RURAL HYGIENE

SOME RESULTS OF RURAL HYGIENE. (*See* p. 329.)

The flower-pot in the centre of the picture is marked in inches in order to afford a correct notion the size of the fruits, vegetables, and flowers.

ESSAYS

ON

RURAL HYGIENE

BY

GEORGE VIVIAN POORE, M.D., F.R.C.P.

COMMANDER OF THE DANNEBROG

EMERITUS PROFESSOR OF MEDICINE AND CLINICAL MEDICINE

UNIVERSITY COLLEGE, LONDON

CONSULTING PHYSICIAN TO UNIVERSITY COLLEGE HOSPITAL, ETC.

'Ces tas d'ordures du coin des bornes, ces tombereaux de boue cahotés la nuit dans les rues, ces affreux tonneaux de la voirie, ces fétides écoulements de fange souterraine que le pavé vous cache, savez-vous ce que c'est? C'est de la prairie en fleur, c'est de l'herbe verte, c'est du serpolet et du thym et de la sauge, c'est du gibier, c'est du bétail, c'est le mugissement satisfait des grands bœufs le soir, c'est du foin parfumé, c'est du blé doré, c'est du pain sur votre table, c'est du sang chaud dans vos veines, c'est de la santé, c'est de la joie, c'est de la vie. Ainsi le veut cette création mysterieuse qui est la transformation sur la terre et la transfiguration dans le ciel.

'Rendez cela au grand creuset; votre abondance en sortira. La nutrition des plaines fait la nourriture des hommes.

'Vous êtes maîtres de perdre cette richesse, et de me trouver ridicule par-dessus le marché. Ce sera là le chef d'œuvre de votre ignorance.'

VICTOR HUGO (*Les Misérables*).

THIRD EDITION

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PREFACE

TO

THE THIRD EDITION

The fact that a third edition of this work has become necessary may, the Author hopes, be taken as an indication that the principles of sanitation which he advocates are meeting with increased acceptance.

It is evident that the elaborate methods of sanitation which are necessary in towns are too expensive and otherwise unsuited for the rural householder, who is dependent for his living upon the productions of the soil, and who must be taught to return all refuse matter to the soil, with a view to increase its fertility.

The Author has taken advantage of this new edition to rearrange much of his material and present it in more orderly form. There have been several additions of new, and some few deletions of old, matter.

The Author is much indebted to his friend Mr. George Pernet for valuable assistance in preparing this volume for the press.

July 1903.

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ON

RURAL HYGIENE

CHAPTER I

INTRODUCTORY

In the ensuing chapters the author will attempt to show that many of the hygienic arrangements which have been in vogue for some years are largely based upon erroneous principles; and are, therefore, bad from many points of view, scientific, political, moral, economic, and hygienic.

The title of 'Rural Hygiene' has been chosen because it is only in places having a rural or semi-rural character that it is possible to be guided by scientific principles in our measures for the preservation of health and the prevention of disease. In cities the hygienic arrangements are the products of expediency rather than principle, and are not unfrequently carried out in defiance of the teachings of pure science. Overcrowding is encouraged, and rivers or other sources of water are recklessly fouled, because such conditions are, or are supposed to be, 'good for trade.' Our municipal governors, who are mainly selected from the trading classes, and the majority of

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whom have had no scientific training of any kind, are rarely capable of looking beyond the question of immediate profit, which to them seems all-important. If a so-called sanitary measure seems likely to increase the rateable value of a district for the time being, that is generally regarded as sufficient ground for action, and money is recklessly borrowed to carry out expensive and half-considered measures, in which the work of sanitation is merely begun and rarely completed.

The hygienic measures of cities have, for the most part, been hastily adopted in order to escape the dangers which are inseparable from an undue concentration of population. They may be compared to the herculean method which was practised upon the stables of King Augeas, and although we may admire the prowess of Hercules, we can find nothing but contempt for Augeas, who would have been happier and richer had he kept his oxen in a rational way.

The 'good for trade' doctrine is fatal to sound sanitary measures, because Mr. 'Good for Trade' (as Bunyan might have called him) will not for a moment listen to any proposition for limiting, however slightly, the concentration of population. 'Good for Trade' is fond of big schemes, the money for which is borrowed, and so long as the money is spent he does not much care upon what. There can be no doubt that the almost unlimited powers of borrowing which our municipalities possess have been harmful in so far as they have encouraged sanitary authorities to act precipitately when otherwise they would have been obliged to move slowly and cautiously, and in doing so would have gained their experience.

Mr. 'Good for Trade' is often not deficient in cunning, and is quite capable of seeing how advantageous are big sanitary schemes for landowners, building specu-

lators, water shareholders, contractors, and the crowd of tradesmen and labourers who follow in their train. He thoroughly understands the various methods by which what is known as 'bringing down the Local Government Board' is brought about, and then, when the groaning ratepayer complains, he protests that the local authority is helpless because of the action of the Government.

The title of 'Rural Hygiene' has been chosen not only because it is in the country alone that Hygiene can be based upon *principles* rather than *expediency*, but also from a feeling that if the rural element be entirely banished from our towns, and if the fearful concentration of population which is seen in the modern city, both here and in America, be allowed to proceed unchecked, we are in a fair way to increase rather than decrease the liability of our towns to suffer from epidemics.

'God made the country and man made the town,' said the poet Cowper, and this is a saying which is not only true but filled with deap meaning for those who are interested in the physical and moral welfare of our populations. It is to be hoped that rural districts will make every effort to retain their rural character, and that, if those sanitary measures which foster overcrowding be forced upon them, they will put some compensating restraint upon the owner of 'eligible sites' and the speculative builder. With our modern methods of communication such dangerous concentration of population cannot be necessary, and one hopes that before many years people will begin to see the advantages not only of the *rus in urbe* but also of the *urbs in rure*.

We hear a great deal of the dulness of rural districts, but it must be remembered that in reality our modern methods of communication have placed all the more solid

advantages of the town within reach of the villages, and that a dweller in even the most remote of our villages is able, if he be so minded, at very small expense, to keep himself abreast of modern ideas in all departments of knowledge.

The big towns are daily becoming more and more a menace to the country. Might is right in the present day, as it ever has been, and it makes little difference whether oppression be practised by fists or votes.

If, however, big towns be allowed to devastate rural districts and drain rivers to dryness in order that they may have a gigantic water-supply with the main object of still further concentrating the population in their boundaries; if the big towns be allowed to use the neighbouring counties as dumping-grounds for nuisances; if they be allowed to foul the rivers so that the fishing industries are destroyed, and it is dangerous for the countryman's cattle to drink from them; if they be allowed to empty their filth along the foreshore of places which are miles distant; if they be permitted to send their paupers into one county, their lunatics into a second, their scarlet fever cases to a third, and their small-pox to a fourth, it is evident that the country people must rush to the towns in self-defence. It is to be hoped that it may some day be recognised that rural districts have their rights. Free trade is indispensable for the existence of our big towns, and while it has enabled the country at large to grow rich it certainly has not been an unmixed blessing to rural districts. The rural districts have, so to say, sacrificed themselves for the sake of the towns, and are now finding out that they have been nurturing a set of Frankenstein monsters, which are devoid of gratitude and return evil for good.

The passing of the Parish Councils Act makes it

necessary to point out that the sanitary problems of the village are much simpler than those of the town. In the majority of villages the only thing really necessary is to beget, in the mind of the individual, the wish and the determination to be cleanly. If the will be present, there are no difficulties whatever. With ample space, fresh air, sunlight, and vegetation, there can be no sanitary difficulties other than those which we wilfully create for ourselves.

The great danger in village sanitation is the tendency to 'follow the fashion,' and the possibility that the rustic mind may think that the sanitary measures of London and the big towns must be right, and therefore to be imitated. As such a course would undoubtedly make the sanitary condition of our villages worse instead of better, it becomes necessary to point out how different are the conditions which obtain in rural districts as compared with town districts.

It must always be remembered that the rural districts are, as a rule, much poorer than the town districts. In towns, especially in London and the great manufacturing centres, where very large incomes are earned, the inhabitants are not accustomed to look closely to the amount paid for rates, provided that trade continues to be tolerably prosperous.

In towns there are few landowners, but many householders, and as houses are held upon leases which are terminable at option, the house occupier, who has little local feeling, and who knows that he can easily let his house to some one else, does not trouble himself about his rates more than to drop a hasty expression when he finds the ever-increasing demand note upon his table, and then to write a cheque.

Increase of Rates

From the 'Times' of January 9, 1903, I have borrowed the following interesting paragraph:—

'In 1874–75 the total outstanding loans of local authorities in England and Wales were 92,820,100*l.* In the course of twelve years the local debt of England and Wales had risen to 186,821,642*l.*, and by the end of 1899–1900 it had reached the enormous total of 293,864,000*l.* Between the years 1874–75 and 1898–99 the National Debt of the whole country was reduced by 141,000,000*l.*, and in the same period the outstanding local debts of England and Wales increased by 185,000,000*l.* This double process caused an advance in the proportion of local indebtedness to the National Debt from 12 per cent. in 1874–75 to 44 per cent. in 1898–99. The rateable value of the properties assessed by local authorities increased largely during this period; but the debt so far outstripped the valuation that in 1898-99 the authorities had incurred debt to the amount of 160 per cent. of the rateable value as compared with 80 per cent. in 1874–75. The growing desire of municipal authorities to embark on trading undertakings has been responsible for nearly half the debt; the remainder has been incurred for Poor Law purposes, highways, and street improvements, and sewerage and sewage disposal works. While it is claimed that the service of the remunerative debt as a whole is largely provided for out of the trading receipts, yet the security for this debt is the rates; and the money to construct the remunerative works would never have been advanced by investors unless the rates had been there to stand the racket if the municipal trading proved unremunerative.'

What the reckless extravagance of our local governors

means is not always appreciated by the bulk of the municipal electors, who are compound householders. It is evident, however, that some of our greatest industries are seriously crippled.

At the half-yearly meeting of the Great Eastern Railway Company on January 28, 1903, the chairman, Lord Claud Hamilton, made the following statement as to the increase of local rates as affecting the Great Eastern:—

'RATES AND MUNICIPAL TRADING

'Dealing next with the expenditure side, he drew particular attention to the ominous item rates and taxes. These showed an increase of 7,500*l.* In order to illustrate their growth he stated that in 1891 they paid 136,500*l.* in rates and taxes, and in 1901 270,300*l.*, or an increase of 98 per cent. Take the rates they paid in two districts celebrated for their municipal enterprise and the consequent effect upon the ratepayers. In the parish of Walthamstow in 1891 this railway's assessment was 6,500*l.*; in 1901 it was 12,600*l.*, or an increase of 94 per cent. The rates and taxes they paid in Walthamstow in 1891 were 1,540*l.*; in 1901 they were 3,746*l.*, or an increase of 143 per cent. Taking the more celebrated borough of West Ham, in 1891 their assessment there was 33,832*l.*; in 1891 it was 96,882*l.* They paid in rates in West Ham in 1891 7,606*l.*, and in 1901 35,679*l.*, or an increase of 369 per cent. ("Shame.") These figures needed no comment from him.'

Town property has increased in value during recent years, while rural property has diminished.

It is evident that rateable value as applied to houses

must be a very precarious value, and, just as districts *from some cause or other suddenly become fashion*able, and rise in value, so the fickleness of trade and fortune may as suddenly reduce the value of districts; but the possible future bankruptcy of a locality is one of those things which does not trouble the modern trader or artisan, provided he has benefited by the loan.

While there are many localities the popularity of which is due to the possession of some natural advantage, such as a fine harbour or a navigable river, or the proximity of valuable minerals, which are calculated to give some permanence to its popularity, so there are other localities the popularity of which seems to depend upon causes of a less stable kind, and which are exposed as it were to all the chances and changes which may be produced by 'competition.' It is competition which has forced upon Manchester the necessity of making a canal, and as the trade of Manchester is its life blood, the ratepayers as a whole have been compulsorily taxed for the support of the manufacturer.

So long as the trade of a district is increasing, the sum paid in local rates is practically of small consequence.

Mr. George Clare, at a meeting of the Institute of Bankers in January 1894, pointed out that of the 201 millions of local debt, seventy millions, or rather more than one-third, had been spent on sewerage, street improvements, and parks. This portion of the debt was unproductive, and could be described as 'dead weight.' Against the liabilities for sanitation and improvements must be set off the public gain in health and happiness; but expenditure of this class, the lecturer said, could not be undertaken too carefully, as our daily increasing knowledge of the laws of health taught that many mis-

takes had been made in the past, and that sooner or later much sanitary work would have to be undone, for the doing of which money was still owing.

Rural districts have only one industry, viz. agriculture; and the fact of agricultural depression is one which is universally admitted. The tithe rent-charge which was worth 112*l.* in 1875, and had fallen to 76*l.* in 1891, is eloquent in this connexion.

It must not be forgotten that the expenses of the Parish Councils fall upon the poor-rate, and that the poor-rate is one which in villages falls heavily and almost exclusively upon the landholder.

There may be those who fancy that rural villages will be anxious to follow the example of the towns, and that they will be handed over to the tender mercies of 'sanitary engineers' for the perpetration of sewage schemes and water schemes. Happily, however, the rural districts rarely have money enough to entertain such extravagant notions, and, although with the aid of the District Councils and County Councils the rural parishes will be able to raise loans, it must be remembered that such loans will have to be raised on the security of rates levied upon an industry which in many places is almost bankrupt.

It must be borne in mind that, although the County Councils have the power to appoint medical officers, some have not yet availed themselves of this privilege; and one reason for this undoubtedly is the fear that the enormous rise of local taxation which sanitary works involve will necessarily follow upon the appointment of an officer, one of whose duties may be to make recommendations which could not be neglected. The apathy of County Councils in this connexion gives some probability that village Councils will not find

it very easy to raise loans, even should they wish to do so.

In the chapters which follow an attempt will be made to set forth the true principles which should guide our actions in procuring a healthy house, pure air, good water, and cheap and wholesome food.

It will be first of all demonstrated that a neglect of sound principles lands us in difficulties, and accordingly the first of the subsequent chapters will be devoted to the evils which arise from an over-concentration of population; it will further be insisted upon that this over-concentration is an indirect effect of our modern sanitary methods, which give what may be called a fatal facility for the packing of houses in dangerous proximity to each other. This over-concentration is often defended on the ground that it is necessary for the purposes of commerce, but not a few facts will be brought forward which tend to throw considerable doubts on the economic advantages of such concentration. It will be argued that the retention of a rural element in our rapidly developing towns and the allowing of open spaces to interpenetrate and dovetail with the houses has not only great advantages on the score of health, but will be shown to be equally advantageous when regarded in its purely financial and economic aspects.

In the third chapter the shortcomings of modern sanitary methods will be dealt with, and it will be shown that the mixing of putrescible matter with water is a fundamental scientific error which leads to the dissemination of water-borne diseases, the pollution of rivers, and the poisoning of wells. Whether such methods be regarded in the modern light of bacteriology or of the evils and expenses of which they are notoriously the cause, they must be condemned as unscientific, thriftless,

and immoral. They are unscientific because they encourage putrefaction and hinder nitrification; they are thriftless because they merely waste or practically destroy that which, rightly used, should be a source of profit and productiveness; and they are immoral because, by merely 'passing on' our refuse to be a nuisance elsewhere than on our own premises, we show a forgetfulness of our duty towards our neighbour and we do unto others that which we are unwilling that others should do unto us.

In the fourth chapter, on 'The Living Earth,' it will be shown that the humus possesses (in virtue of the animal and vegetable organisms which it contains) a marvellous power not only of turning organic matter into food for plants by what is known as the process of nitrification, but that while in this way it tends to increase our food-supplies, it is no less powerful, if rightly and scientifically used, to protect our wells from all dangerous animal pollutions.

The necessary relations which exist between earth and water are discussed, and it is shown that every individual requires a definite minimum amount of earth, air, and water in order to live. Modern methods of communication combined with the unrestricted importations of food have enabled us to neglect what may be called the 'earth-unit,' and to concentrate our population in a disastrous fashion, and it is largely due to this neglect of the earth-unit that our increasing difficulties with regard to municipal water-supplies are due, difficulties which must, one would fear, grow progressively greater.

In dealing with the subject of 'The House' in the fifth chapter, the many evils which are practically inseparable from what are known as modern sanitary fittings are passed in review, and it is insisted upon that no house can be securely and permanently wholesome

unless it has tolerably direct relations with cultivable land. The modern practice of erecting houses on insufficient area and the evil consequences resulting from such practices are dwelt upon, and it is pointed out that the planning of town houses involves problems which need not and ought not to trouble the architect of country houses. A few words will be said on the subject of those buildings which are designed for the reception of large numbers of people, such as hotels, barracks, and schools.

The subject of 'Air' is discussed in the sixth chapter. A few elementary facts with regard to air are first given, and then the relationship which exists between the earth and the air is discussed; it is insisted upon that vegetation is essential for the freshening of the air; and that when, as in overcrowded cities, the air becomes too foul to allow vegetation to flourish, this in itself constitutes a danger to health, for without vegetation neither is the air freshened nor the soil purified.

The point which receives most attention when discussing the question of 'Water' in the seventh chapter is the great difficulty of purifying water which has once been fouled, and the doubts which surround all the common processes which are at present advocated for that purpose. It will be shown that, if we want pure water, a scientific and careful bestowal of putrescible refuse is the first thing necessary; that while putrescible matter mixed with water and allowed to accumulate in underground receptacles not only escapes the salutary action of the humus, but, leaking under pressure, inevitably trickles unchanged to our wells, however deep they may be, the same matter, if superficially buried in the humus and allowed to oxidise and nitrify, is not likely to foul a properly made well, no matter how shallow it may be.

In the eighth, ninth, tenth, and eleventh chapters the author gives his personal experiences in dealing with the problem of domestic sanitation. The principles which should guide us in the management of sanitary details are discussed, and arrangements are described which are believed to be satisfactory, at least in the circumstances for which they were designed. It must, however, always be borne in mind that circumstances cannot be neglected when dealing with the questions of sanitation, and that the discovery of a sanitary panacea will certainly never be made. The peculiar questions which arise when dealing with the sanitation of cottages will be dealt with, and the best methods of refuse-disposal and water-supply in relation to cottages will receive attention. The burning sanitary questions which arise in country towns and in growing suburbs will be illustrated by personal experiences, which the bulk of readers will recognise as having been in no degree exceptional.

A chapter on 'Burial' has been inserted as being part of the great question of the right bestowal of effete organic matter, and the power of the earth to deal with the dead body as satisfactorily as it deals with all other forms of dead organic matter is insisted upon.

The final chapter is devoted to the story of Brémontier, which is inserted as the best example known to the author of the glorious results which have been obtained by a patient waiting upon nature in the true scientific spirit.

It is hardly necessary for the author to say that in bringing out this little book he has been prompted solely by a deep sense of the importance of the subject which is discussed in it. It is important not only to the individual but to the nation at large. The bestowal of refuse is a problem which confronts every individual

daily and almost hourly. We may practically destroy it so that our native soil gets no advantage, or we may start it upon a round of creative productiveness which will provide food, warmth, house, and raiment, and in so doing find perpetual occupation for the increasing numbers of 'the unemployed.' To what extent it might be possible for the towns to mitigate the prevailing agricultural distress by supplying farmers with manurial matters at cheap rate is a question well worthy of consideration. Looked at philosophically, the question of the right bestowal of organic refuse is a national question of great political importance which no statesman can neglect, and which has effects vastly more far-reaching than is generally supposed. It is hoped that every patriotic man will ponder the question seriously, and will recognise that it has its moral side. It is the duty of each of us to take care that we do not, by apathetic carelessness or culpable ignorance, endanger the health of others, and we must remember that it is no excuse for the adoption of bad and dangerous methods of sanitation to urge that they are 'convenient.' Such an excuse might be put forward in defence of acts which we all recognise as criminal. We are individually under a moral obligation to see the refuse of our dwellings safely bestowed, so as not to endanger the health of others; but in these matters we are too prone to allow 'rates' to take the place of morals, and to expect a collection of individuals, merely because they are called a 'board,' to be able to do for us that which we ignorantly profess to be unable to do for ourselves. In sanitary matters, more than in any others perhaps, we are gradually losing our freedom; but it is high time for the individual to rouse himself to a sense of duty, and insist on his right to individual liberty.

CHAPTER II

THE CONCENTRATION OF POPULATION IN CITIES

The steadily increasing tendency of population to leave the country and concentrate in towns is a fact which does not admit of a doubt. Of the thirty-two millions and a half of inhabitants of England and Wales, about twenty-five millions are classified by the Registrar-General as belonging to the town districts and about 7,500,000 as belonging to country districts. In 1801 London contained about one-eleventh of the entire population of England and Wales, whereas, according to the last census, it was found to contain about one-seventh of the entire population. Dr. Gould, of Washington, in a paper read before the seventh International Congress of Hygiene and Demography, stated that a short half-century ago the urban population of the United States was 8·5 per cent. of the whole, while to-day the urban population constitutes 29 per cent. of the whole. The American city, says Dr. Gould, 'creates itself with appalling suddenness,' and it is probable that Chicago, with its 1,758,000 inhabitants, having doubled its population in the last few years, may be said in this particular matter to have beaten the record. It must not be forgotten, however, that London has more than doubled its population in the last half-century; that Cardiff has risen from 129,000 to 164,000 inhabitants in

the last ten years; that Barrow-in-Furness, Eastbourne, Bournemouth, West Ham, and Croydon are all instances of towns, besides many others, which have sprung into existence within the memory of the present generation. It is important to bear these facts in mind, as showing that the English cities, equally with those in America, create themselves with appalling suddenness; that we do not merely inherit our cities with their various shortcomings, but that we create them for ourselves, and are directly and solely answerable for their good or ill construction.

The cause of this concentration of population is the desire for business, the wish to get money easily and quickly, and to spend it advantageously. A man who trades in a centre of express mail services, telegraphs, and telephones has all the world before him if he knows how to make use of it. There is consequently a rush for such favoured centres, and it has come about that steam and electricity, which annihilate time and space, instead of enabling us to live further apart from each other, have produced a directly opposite effect. The dealer, be he wholesale or retail, likes to be surrounded by a crowd of potential customers, rather than be dependent on a few; and the artisan naturally turns to great industrial centres as offering the readiest market for his labour, and often finds out too late that the higher wages of the town are more than counterbalanced by the extra cost of living. The crowds of independent and idle persons who settle in the towns do so because they find a greater variety of methods of killing time, or, as they prefer to put it, because the state of civilisation is greater in the towns than in the country. But what is civilisation? A recent anonymous writer (the author of 'Behind the Bungalow') speaks of this 'half-hatched civilisation of ours, which merely distracts our energies by multiplying

our needs, and leaves us no better off than we were before we discovered them;' and we must all admit that there is a good deal of this kind of civilisation which passes current at the present day, especially in cities, where a large proportion of the population are the slaves of inane conventionalities.

Cities are the abodes of art, and art in all its forms is elevating; but it is a question whether the increasing difficulties which, especially in London, we encounter in the study and appreciation of nature do not more than counterbalance the artistic advantages. 'Pictures, taste, Shakespeare, and the musical-glasses' are not the only things worthy the attention of civilised man, and it is noteworthy that many of the leading spirits in all ages have turned from the artificial enjoyments of the town to the greater freedom and more natural pleasures of the country. It is said that our rural fellow-subjects, having been forcibly educated to a pitch which enables them to study all the gay doings of the town, are beginning to find the country insufferably dull. The cause of dulness, however, is in ourselves and not in our surroundings. Our country friends must be taught that they have at hand one of the surest cures for dulness. Let them learn to study and appreciate the book of nature—that book which is always with us, ever open and inexhaustible—and dulness will become impossible.

The mind which has occupation to really interest it cannot be dull or weary, and the surest way to find interest in this life is productive labour. In the making of a pudding, the raising of crops, the writing of books, the practice of a profession, and in all the constructive arts, it is necessary to use the judgment; and it is this exercise of judgment which is the true complement of book-learning. The man who reads and who produces

nothing is seldom capable of action; he becomes giddy with the opinions of others, and finds it impossible to have a fixed opinion of his own. In action and production the mere see-saw of criticism is of no use, we must make up our minds. We must really think, and the man who has learnt to think runs little risk of being dull.

Those who have to cope with the uncertainties of nature are bound to exercise their judgment in a high degree. Unless the farmer be constantly thinking and looking ahead, and unless he bring (often unconsciously) a good deal of science to bear upon his practical work, he will have no chance of success. We are not to sit in judgment on such a one because he does not show the alacrity, sharpness, and power of repartee which are seen in the town dweller. The cockney and the yokel are educated in totally different schools, neither understands the other, and they have for each other a good deal of mutual contempt. It is difficult, however, to believe that he who can perform the varied duties of the farm, and who has been brought up in contact with a wide range of natural phenomena, is not the equal intellectually of the factory hand, who is the slave of a machine which thunders to and fro with brutal accuracy for ten hours at a stretch. Physically, the country labourer is vastly superior to the town dweller, and be it remembered that mental power is mainly dependent on physical health.

Physical Health and Development

One of the undoubted consequences of the concentration of population in towns is deterioration in physical health. The disease-rate and the death-rate are both higher in urban than in country districts. The difficulties of rearing children are much greater in towns than

in the country, and the risk of faulty development in those which are reared is also greater. The undue concentration of population must tend towards the deterioration of our race, and there can be no doubt that the diminution of the evils of such concentration is a subject which demands very earnest attention. We all of us have to run more or less risk in earning our living. Some enter the army or navy, some go to tropical countries, some become file-grinders, hotel servants, or doctors, and it is not, perhaps, desirable that the bread-winners should look too narrowly at the risks connected with their daily work. Every prudent man, however, will endeavour to secure vigorous health for his wife and children; and, whenever it can be avoided, these should not be called upon to run unnecessary risks.

Death-rates are nowadays the subject of perennial paragraphs in the newspapers, they are systematically used for puffing localities, and are beginning to form a recognised feature in auctioneers' advertisements. Before accepting the death-rate as evidence of the healthiness of a locality we must take several facts into consideration. 1. The mobility of the population in the present day is greater than it ever has been previously. This must have a vitiating effect upon the value of the death-rate, for it is evident to all of us that a man who has contracted a fatal disease, let us say in London, may die at Croydon, Brighton, the Riviera, Cairo, or elsewhere. This fact must largely lessen the trustworthiness of local death-rates, although it does not, probably, appreciably affect the trustworthiness of the death-rate for the country as a whole. Estimated death-rates are often very erroneous. Thus the last census showed that the estimated population of West Ham was 58,278 in excess of the truth. Many other towns had made similar errors,

and it is evident that 'estimated' populations are valueless for statistical purposes. 2. Again, the death-rate of a city is of little value unless correction be made for abnormal age distribution. London, especially the central parts of it, contains a great deficiency of persons at the extreme (and most vulnerable) periods of life, and this, of course, helps to keep the death-rate lower than it would be if it contained its due proportion of tender infants and feeble old persons. The population of central London, it must be remembered, is largely composed of selected adults imported from the country. 3. Lastly, let it be observed that the death-rate of London is kept down very largely by a process of dilution. If any comparison is to be made between the London of to-day and the London of former times, we must be careful to select identical areas. As it is, the high death-rate of the centre is diluted by the low death-rates of the outskirts, and the healthiness of Hampstead, Lewisham, and other outlying districts conceals the condition of the centre.

That mortality is proportional to density of population is shown by the following table (Table R, p. xlvii), taken from the decennial supplement (1895) of the Registrar-General.

Persons to a square mile	Death-rate (corrected)	Persons to a square mile	Death-rate (corrected)
138	12·70	1,803	20·43
187	14·48	3,299	22·30
307	16·47	4,295	24·51
662	18·55	19,584	33·00

The corrected death-rate for 'Urban England,' as given by the same authority, is 22·32, as against 16·95 for 'Rural England.'

It is probable that in no city are the annual variations of population greater than in London. The

population of June (the height of the season) and the population of September (when 'everybody is out of town') must be very different. In September the rich go to the country, the shopkeepers go to the seaside, and the poorest of the poor go hop-picking. The School Board attendances for the first week of September show a deficit of 80,700 children, or 11·1 per cent., figures which clearly demonstrate that the autumn exodus is not limited to the wealthy classes.

It is at this season that we see paragraphs in the paper to the effect that the death-rate of some London parish for the Michaelmas quarter reached an incredibly low figure, and we are asked to infer that the population, thanks to the wise policy pursued by the Borough Council, is fast making for immortality. Of course such statements are not worth the paper they are written on, because there are no data as to the population, and the period chosen is so short as to be valueless.

In estimating the death-rates of different sanitary areas of London it has been customary of late years to distribute the deaths occurring in institutions to the districts to which the deceased 'belonged,' and to exclude entirely the deaths of persons belonging to districts outside registration London; in this way about 1·5 per cent. of the deaths occurring in registration London may be excluded. This manœuvre helps to diminish the London death-rate, but, as no account is taken of sick people who leave London to die elsewhere, it is manifestly an unjustifiable thing to do.

If the strangers who die in London institutions are to be excluded, it is a question whether all strangers merely sojourning in London ought not be excluded from the estimate of population. Again, a man comes from the country and is knocked down by a vehicle in the street

and dies in a London hospital; or during a sojourn in London he gets caught in a London fog and dies of bronchitis; or he 'catches' influenza, or pneumonia, or diphtheria in London and dies. Surely the deaths of these three ought to be credited to London in all fairness. It is a very dangerous thing to 'cook' statistics, and we do not get much nearer the truth by doing so.

The best indication, probably, as to whether the conditions of life in any locality are healthy or the reverse is the infant mortality; in this way we exclude the fallacies due to abnormal age distribution, because we compare identical age periods; and the proportion of the sexes among children is practically the same everywhere. We exclude also the influences of occupation. By studying the mortality of children under five we are studying the influence of the home and home surroundings on the incidence of disease, which is particularly what we wish to do.

In the decennial supplement of the Registrar-General published in 1896, Dr. Tatham gives a table (Table II. p. lxxxii *et seq.*) of the 'annual death-rate per million living among children under five years of age, from all causes and from several causes, 1881–90.' This valuable table ought to be most widely studied. Being based upon statistics of ten years intervening between the censuses of 1881 and 1891, the estimates of population have a maximum of reliability, because we are relieved of the errors inseparable from statistics referring only to short periods of time.

It is constantly stated that London is the healthiest city in the world, a statement which, if true, must make us very sorry for the other cities. In Dr. Tatham's table, alluded to above, he first deals with counties.

We find that the death-rate of *children under five*

from all causes in England was 56,825 per million; that the highest death-rate among children was in Lancashire (72,795), and the next highest was in the county of London (68,164). The lowest death-rate was in the county of Dorset (35,651).

—	All causes	Small-pox	Measles	Scarlet fever	Diphtheria	Whooping cough	Fever	Diarrhœa	Tuberculous disease	Respiratory disease
Lancashire	72,795	37	5,053	2,454	706	3,805	285	6,461	5,364	17,037
London	68,164	240	4,743	1,780	1,371	5,342	165	5,444	6,581	16,021
Hampshire	42,222	10	2,005	505	939	2,508	280	2,783	3,299	9,011
Dorsetshire	35,651	4	1,748	488	493	1,815	62	1,305	2,401	9,390

I have thrown in Hampshire, because not only is it my own county, but it is a mixed county, largely rural, but also containing the big towns of Southampton and Portsmouth.

Looking at these four in tabular form, we see that in Lancashire the mortality from measles, scarlet fever, fever, diarrhœa, and respiratory disease was greater than in London; and in London the mortality from small-pox, diphtheria, whooping cough, and tuberculous disease was greater than in Lancashire.

In Hampshire and Dorsetshire the mortality was very much less from every cause than in either Lancashire or London.

It is important to point out that the deaths of children from tuberculous disease are greater in London than in any other county, and that the deaths from tuberculous and respiratory disease combined are greater in London than in Lancashire.

We have seen that the mortality of children under five averaged for the whole of London 68,164 in the decennium 1881–90, while that for England and Wales

was 56,825, or, omitting the last three figures, let us say they were 68 and 57.

Examining the various registration districts more closely, we find that the child mortality was less than the average for England and Wales in four London districts only, viz. Lewisham (44), Hampstead (48), Woolwich (51), and Wandsworth (56), districts which are all on the outskirts of a place we call London. Certain other districts had a child mortality less than the average of London as a whole, viz. Camberwell (59), Hackney (60), Islington (61), Paddington and Kensington (63), Greenwich (63), St. Pancras (66), Fulham, Poplar, and Lambeth (67).

All the other districts had a child mortality greater than the average of London, viz. Mile End (69), St. George's, Hanover Square (71), Westminster (72), Chelsea and St. Olave's (73), Marylebone (75), Bethnal Green (76), Shoreditch (78), St. Saviour's (79), St. Giles's (80), Holborn (82), Whitechapel (85), St. George's-in-the-East (87), the City (90), Stepney (99), and the Strand (109).

With the exception of the City, Stepney, and the Strand, there are only two registration districts in the whole country which have a child mortality over 90, viz. Manchester (93) and Liverpool (114). To Liverpool therefore belongs the distinction of being the most unwholesome place for little children in the whole country, and the 'Strand,' which constitutes the very centre of London, comes next.[1]

Let us examine these figures more closely, and let us throw the child mortality of Liverpool and the Strand into tabular form, and contrast them with the registration district of Andover, in Hampshire, a district which I select for reasons which will appear later.

[1] The registration district known as the 'Strand' is at present (1903)

—	All causes	Small-pox	Measles	Scarlet fever	Diphtheria	Whooping cough	Fever	Diarrhœa	Tuberculous disease	Respiratory disease
Liverpool	114,258	29	9,492	2,966	852	5,894	483	9,818	7,138	26,080
Strand	109,596	38	6,626	1,828	4,760	6,359	76	7,692	11,881	30,122
Andover	32,260	0	1,227	307	225	2,505	153	1,074	2,096	7,209

From this table it appears that the mortality from measles, scarlet fever, and diarrhœa was greater in Liverpool than in the Strand; but that the other diseases scheduled were more fatal in the Strand than in Liverpool.

We have previously pointed out that the deaths of children from tuberculous and respiratory diseases are greater in London than in any other county, and now we find that the death-rate of children from these two classes of diseases amounted in the 'Strand' to 42,003, far and away the highest figure in the country, Liverpool coming second with 33,218. The death-rate of children from the same causes in Andover was only 9,305, considerably less than a quarter of the Strand death-rate.

Thanks to vaccination and the purity of the water-supply the mortality in the Strand from small-pox and fever was very small, but the mortality of children from the acute air-borne contagia (measles, whooping cough, scarlet fever, and diphtheria), and still more from the chronic air-borne contagia, was fearful to contemplate.

The big mortality from tuberculous disease forces upon us the reflection that a large number of children who became tuberculous in the 'Strand' did not die within the age limits with which we are concerned, but dropped off later in life after years of invalidism and

undergoing extensive demolition and reconstruction. It is now part of the City of Westminster.

suffering. We have seen that children under five were decimated yearly in the Strand. How many more were crippled for life?

The death of children under one year of age per 1,000 births is a safe criterion of the health conditions of a locality. This figure for the ten years 1881–90 was, for the whole of England and Wales, 142. In London, we find that in five districts (Hampstead 117, Lewisham 121, Woolwich 124, Hackney 137, and Wandsworth 141) this mortality was below the average of the whole country, while in the remaining twenty-five districts it was above the average.

In Paddington, Islington, Camberwell, Lambeth, Greenwich, Mile End, Poplar, and Marylebone, it was above 142 and under 150. In St. Pancras, Kensington, St. George's (Hanover Square), St. Giles's, Bethnal Green, and St. Olave's, it was above 150 and under 160; in Chelsea, Fulham, Westminster, Holborn, Shoreditch, and St. Saviour's, it was over 160 and under 170. The City was 171, Whitechapel 173, St. George's-in-the-East 182, Stepney 196, the Strand 226.

To show what this figure of 226—the infant mortality of the Strand—means, I will give the infant mortality of some of the worst towns in Lancashire: in Liverpool 219, Wigan 161, Bolton 163, Salford 183, Manchester 193, Ashton-under-Lyne 173, Oldham 169, Rochdale 145, Burnley 184, Blackburn 178, Preston 203. On the other hand, one may say that the infant mortality of Andover, which has just adopted a great part of the London Building Act, with the approval of the Local Government Board, was (for the ten years 1881–90) 91, or 23 per cent. less than the best of the London districts, and nearly 60 per cent. better than the Strand.

Glancing at the other Hampshire districts, one may

note that in the New Forest the infant mortality was as low as 80, and that it was only in Portsea Island (139), Alverstoke (123), and Southampton (135) that even the lowest of the metropolitan figures were approached. It is interesting to note that even the worst districts in Hampshire are below the average of the whole kingdom in the matter of infant mortality.

London Registration Districts

In the 'Annual Summary of Births, Deaths, and Causes of Death in London and other Great Towns, 1893,' published by the authority of the Registrar-General, will be found a table (Table 9) giving the London mortality in five groups of districts, from 1841 to 1893.

Let us first take from this table the mean rate of mortality in the five decennia intervening between the beginning of 1841 and the end of 1890.

In the western districts the mean rates of mortality have been 23·0, 22·6, 22·7, 20·8, 19·7.

In the northern districts the mean rates of mortality have been 22·7, 22·2, 23·6, 21·9, 19·1.

In the eastern districts the mean rates of mortality have been 26·2, 25·1, 26·9, 25·0, 23·7.

In the southern districts the mean rates have been 26·2, 24·4, 23·4, 21·9, 19·5.

Thus it will be seen that in all these districts the rates of mortality have tended steadily to diminish between 1841 and 1891, this diminution being most marked in the southern districts and least marked in the eastern districts.

When, however, we come to the central districts we find no such steady diminution, the mean rates of

mortality for the five successive decennia having been 24·7, 24·4, 26·5, 24·9, 23·3.

This seems a fact of such prime importance that it is advisable to consider it more in detail, and accordingly I add from this table the death-rates in the central districts for every year, from 1841 to 1893.

Annual Rate of Mortality in Central Districts.

1841	25·0	1868	25·2
1842	23·6	1869	26·6
1843	25·3	1870	26·0
1844	24·4	1871	25·0
1845	24·0	1872	23·6
1846	22·9	1873	25·1
1847	27·9	1874	25·7
1848	25·3	1875	26·2
1849	27·9	1876	24·1
1850	21·1	1877	24·2
1851	24·1	1878	25·2
1852	23·9	1879	26·3
1853	25·1	1880	23·8
1854	27·4	1881	23·4
1855	25·1	1882	24·0
1856	23·0	1883	23·3
1857	23·8	1884	23·8
1858	24·5	1885	22·9
1859	24·1	1886	23·4
1860	23·3	1887	23·5
1861	25·4	1888	22·7
1862	26·2	1889	20·9
1863	26·9	1890	24·8
1864	29·5	1891	26·5
1865	27·1	1892	24·0
1866	27·1	1893	25·7
1867	24·8		

We thus arrive at the rather startling fact that there has been no material decrease of the mortality in these central districts in the half-century intervening between 1841 and 1893.

Compared with the high rate in the central districts of 25·7 for the year 1893, we find that the rate for the same year in the other districts of London was as fol-

lows:—Western, 19·7; Northern, 20·2; Eastern, 24·9; and Southern, 19·5. The rate of mortality for the whole of London in 1893 was 21·3.

We naturally look for some explanation of this high mortality in the centre of London. Is it due to the hospitals contained in the central districts of London, and do the inhabitants of outlying districts flock to hospitals and institutions in the central districts to die in them, and thus unduly swell the mortality?

The answer to this is 'No;' for a table (Table 11) included in these reports gives a corrected return of birth and death rates for the districts of London, in which the deaths of non-residents occurring in hospitals have not been included.*

From this it appears that the corrected death-rates for the central districts of London were as follows, and for the sake of comparison I have placed the uncorrected death-rates alongside them:—

Central districts	Uncorrected	Corrected
1891	26·5	27·6
1892	24·0	25·1
1893	25·7	26·6

It thus appears that more persons left the central districts to die elsewhere than came from the other districts to die in them, and that the true death-rate of the central districts for the past three years averaged 26·4.

Before the death-rate of the central districts can be acknowledged as true, a further correction must be made for age and sex distribution. This correction we are able to make approximately because for the last two years the Registrar-General has given for the big towns a table of corrected rates, in which allowance is made for abnormities of age and sex distribution

From this table it appears that if the mortality of

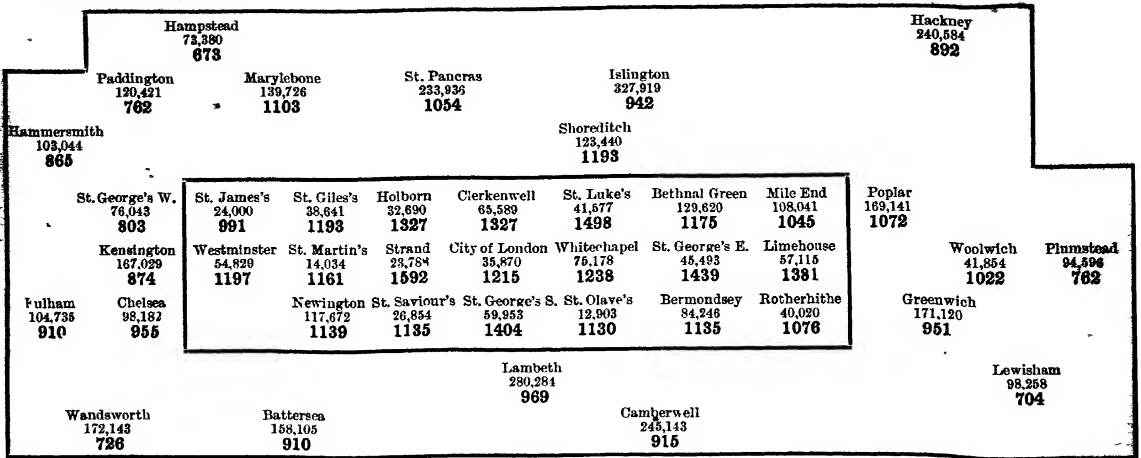
MORTALITY FIGURES

(Figures in small type show the population of the Sanitary Areas)

ENGLAND AND WALES=860

1893

LONDON (entire)=1000



DR=Corrected Death-rate

1892

MF=Mortality Figures

	DR	MF		DR	MF		DR	MF		DR	MF		DR	MF
Hampstead	14·2	657	Battersea	19·4	898	**London (entire)**	**21·6**	**1000**	Bethnal Green	24·1	1115	Clerkenwell	27·5	1273
Lewisham	15·7	727	Kensington			Chelsea	22·0	1019	Bermondsey	24·3	1125	St. George's, Southwark		
Plumstead			Greenwich	19·7	912	Rotherhithe	22·2	1028	City of London	25·3	1171	Limehouse	27·8	1287
Wandsworth	16·8	778	Camberwell	19 9	921	Woolwich	22·8	1056	Newington	25 5	1181	St. Martin's in the Fields	[illegible]	1292
Hackney	18 1	838	Islington	20 1	931	Poplar	23·2	1074	St. Giles	26·2	1213	St. Olave's	28·1	1301
England and Wales	**19·0**	**880**	St. James's, W.	20·2	935	St. Marylebone	23 4	1083	Westminster	26·6	1231	St. Luke's	28·2	1306
Paddington	19·3	894	Lambeth	20·7	958	St. Pancras	23·5	1088	St. Saviour, Southwark	26·7	1236	St. George's East	28·8	1333
St. George's, Hanover Square			Hammersmith	20·8	963	Mile End	23 8	1102				Holborn	29·7	1375
			Fulham	20·9	968	Shoreditch	23·9	1106	Whitechapel	26·8	1241	Strand	33·4	1546

London as a whole did not exceed that of the country as a whole, then the mortality, allowing for age and sex distribution, should be *below* that of England and Wales, and should amount to 17·97 only for 1893. The recorded death-rate for London as a whole in 1893 was 21·31, but the corrected death-rate, allowance being made for age and sex distribution, was 22·71.

Mr. Shirley Murphy has given the 'mortality figures' for London districts after correction for hospitals, age, and sex, and these I have thrown into tabular form.

This table and plan (p. 30) shows at a glance that the mortality of London as a whole (taken as 1,000) is 14 or 15 per cent. higher than that of England and Wales, and that while some of the outlying districts, such as Hampstead, Lewisham, and Plumstead, have a mortality below that of England and Wales, the areas near the centre of London are all considerably above it; and some, such as the Strand, Holborn, St. George's-in-the-East, and Whitechapel, have a mortality as high as that of the worst manufacturing towns.

The danger of overcrowding is well shown by the explosive outburst of small-pox in Marylebone in 1894.

Fig. 1, p. 32, represents part of the Asylums Board Map, in which each case of notified small-pox is shown by a black dot. This map shows that the outbreak was limited to two spots, one in Portland Town and one round Nightingale Street, Edgware Road, where the density of population, according to Mr. Charles Booth, is over 300 persons to the acre.

In looking at these death-rates for the central districts from 1841 to 1890 one cannot but be struck with their comparative uniformity, and the absence of figures which seem to point to any particular years as especially pestilential. In 1846, 1847, 1848, and 1849—years

memorable for want, social disturbance, and cholera—the death-rate averaged 26 only. In 1854—a year of

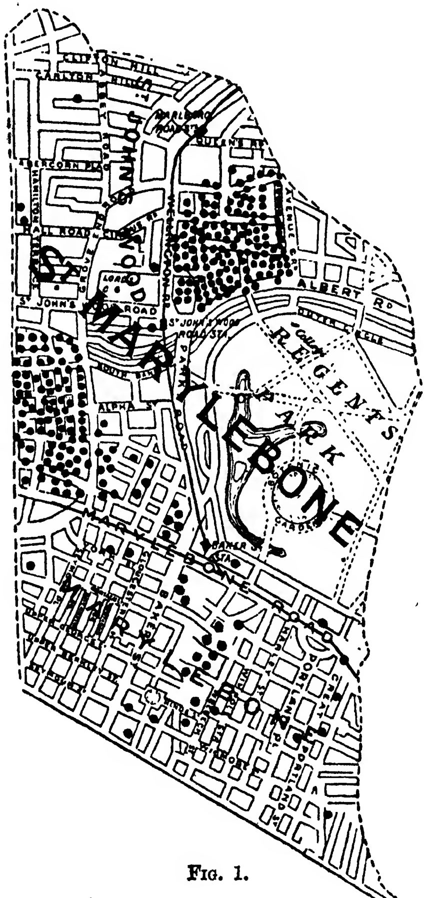


Fig. 1.

cholera—it was 27·4; and in 1866—another cholera year—it was 27·1.

The highest death-rate was in 1864, when it stood at 29·5; the lowest recorded was in 1850, when it stood at 21·1.

The fact that the cholera years make so small a show in the death-rates is interesting, because, as is well known, these districts have enjoyed the excellent water-supply of the New River, and did not in 1854 and 1866 get any material part of their water from the Thames between the bridges or from the polluted Lea.

There is, in fact, no reason why these central districts should suffer from the effects of water-borne contagia, more than any other districts; and it appears evident that the high mortality which persists in them is not due to any defect of water supply.

It is rather mortifying to contemplate the persistent high death-rates in these districts, when we consider the money which has been laid out in them for the express purpose of improving their sanitary condition.

The opening of the New River, the rebuilding after the great fire in 1666, the removal of the City walls and gates, the covering of the Fleet Ditch, the making of the main sewers, the construction of the Thames Embankment, the closing of the City churchyards, the laying out of the New Road, Cannon Street, Queen Victoria Street, the Holborn Viaduct, Northumberland Avenue, Farringdon Street, Shaftesbury Avenue, New Oxford Street, the Metropolitan Railway, the improved lighting, the magnificent paving, enforced vaccination, enforced education—these are among the public measures of 'betterment,' every one of which should have the effect of improving the public health.

Again, we have new markets, new bridges, model dwellings, an Adulteration Act, a Notification Act, an army of inspectors for slaughterhouses, dairies, and

factories, and a complete set of hospitals and asylums in neighbouring counties to which are sent paupers, lunatics, imbeciles, and cases of infectious fevers.

These central districts form a city, which is equal in magnificence to any city in the world, and which, when viewed upon a fine day, is calculated to inflame the imagination and rouse every feeling of patriotic pride. Nowhere on the globe can one see a greater concentration of municipal magnificence or a greater variety of fine buildings, whether public or private. Nowhere, probably, is to be found such ample and luxurious hotel accommodation for visitors, and nowhere is there a Vanity Fair more profusely furnished with theatres and halls of pleasure, with shows and shops. Were it not for the fact that the Registrar-General drags a mummy across the scene marked with the figure 28·1, our enjoyment would be unalloyed.

The hygienic difficulty with which these central districts have to contend is not that of water-supply, sewerage, or food-supply, but a difficulty in getting an adequate supply of fresh air.

On paper they appear to have undergone a diminution of population, but from the hygienic point of view such a statement is obviously misleading. It is true that fewer people *sleep* in these districts than was the case thirty years ago; but for at least eighteen hours out of every twenty-four the overcrowding is excessive. Is there any time of the day or night when these districts have not in them some thousands in excess of the sleepers? After the eighteen theatres have closed their doors, the printing-offices of the daily papers are crammed to repletion, and then come the market people; and these are followed by the daily toilers on the busy scene. Judging from the day census of the City proper,

it is quite safe to say that at least a million people visit these central districts daily, of whom probably half a million have occupation there; and these help not only to use up the air, but not improbably leave it 'seeded' with a fair percentage of infective particles. If we look rationally at these central districts we must admit that for practical purposes the overcrowding is infinitely greater than it ever has been.

It is somewhat humiliating to find that after all our efforts the death-rate of Central London has undergone no material change during the last fifty-four years.

It is also rather humiliating to have to admit that the lowering of the death-rate in districts other than the central, is probably due to dilution rather than genuine improvement. In 1841, London contained 1,950,000 inhabitants; to-day it contains 4,536,000, an increase of 2,586,000. At the same time the central districts have decreased to the extent of 250,000, and from this we are entitled to conclude that of the 4,536,000 inhabitants of London, at least 2,800,000 are living in absolutely new districts, which having been developed since 1841, and stretching from the centre into the country, have served to dilute the central death-rates. It is not very far from the truth to say that 60 per cent. at least of the inhabitants of London live in a city which was non-existent fifty years ago, and considering the amount of building which has been carried out since 1841, it is certain that considerably more than 60 per cent. live in houses which are absolutely new.

Although no improvement has taken place in the death-rate of the central districts of London, I do not wish to be understood as speaking lightly of the sanitary work which has been carried on in those districts. Far from it; for it is certain that without the strenuous efforts

which have been made to grapple with the sanitary problems in such a hemmed-in and crowded area, the death-rate must have risen to a far higher figure than any of those which I have quoted.

Again, we must be careful to distinguish between crowding *out of doors* and crowding *indoors*, and we must remember that crowding in houses and under a common roof is infinitely the more dangerous form of crowding.

William Cobbett, in his 'Rural Rides,' invariably speaks of London as 'The Wen,' *i.e.* he regards it as a pathological growth, and there can be no doubt he is correct in his point of view, as is shown by the frequently recurring necessity for surgical interference.

The concentration of houses, and the concentration of inhabitants under a common roof, must increase the amount of air-borne disease, and there can be no doubt that with the increasing height of our houses and the ever-increasing area of the city, the mortality of the centre of London is certain to increase.

In the first quarter of 1892 we had a very sharp epidemic of influenza in London, which lasted for six weeks and caused, approximately, 1,000 extra deaths per week while it lasted. The effect of this epidemic, which was due to air-borne contagia, is shown in the corrected returns of the Registrar-General for the first quarter in 1892.

The death-rate for the whole of London during this quarter was 27·8, and the total deaths amounted to 29,529.

A glance at the returns shows that, roughly speaking, the death-rate of the various districts rises as we proceed from the circumference to the centre of London, and certainly the central districts of the Registrar-General show a rate of mortality which is deserving of attention.

Taking these central districts in order of mortality we find that the death-rates for the first quarter of 1892 were as under:—

Strand	44·0	St. Giles's	35·1
Holborn	36·6	City	33·0
St. Luke's	35·5	St. Martin's	27·7
Clerkenwell	35·3		

The infant mortality figure, which for the whole of London stood at 179, was no less than 317 in the Strand, 244 in the City, 229 in Holborn, 217 in St. Martin's, 212 in Clerkenwell, 186 in St. Giles's, and 170 in St. Luke's.

In St. Luke's the birth-rate for this quarter was exceptionally high (45·2), and the births exceeded the deaths by 99. In each of the other central districts, however, the deaths considerably exceeded the births, a fact which was due as much to the exceptionally low birth-rates as to the exceptionally high death-rates. If we exclude St. Luke's we find that in the six remaining districts the deaths exceeded the births by 452.

The smallness of the birth-rates (St. Martin's, 16·9; City, 17·5; Strand, 24: Holborn, 27; St. Giles's, 30·4; Clerkenwell, 33·5) shows how abnormal must be the age distribution, and that when the human birds pair they have largely given up the central districts for nesting purposes.

Effects of Fog

Finally, let us take London at its worst—as during the great fog of Christmas 1891. Now, in order that fog may be formed, the air must be laden with *moisture*, and consequently in London the winds which bring the fog are those which come from the eastward, over the sea and

up the estuary of the Thames. Fogs are necessarily phenomena which depend upon *stillness* of the air, for they are quickly dissipated by even a moderate breeze. In order that the moisture-laden air may precipitate its moisture in the form of fog it needs to be *chilled*, and, therefore, our winter fogs only occur in cold weather. December 20, 1891, at Greenwich was a clear frosty day with very light air from the north-east. On the following day the wind became due east and dropped to a dead calm, and then commenced a dense fog which continued till the evening of Christmas Day, when the wind shifted to the south-west and the frost and fog came to an end.

In the week ending December 26 six days were frosty, and a dense fog continued for the greater part of five days. The air was almost saturated with moisture. The mean daily value of temperature was 10·2 degrees *below* the average, and amounted to 29·1 degrees only. Out of fifty-four hours during which the sun was above the horizon, sunshine was registered at Greenwich during 4·7 hours only, and the sum of the horizontal movement of the air for the week amounted to 784 miles, or 1,341 miles below the average.

The barometer stood at 30·49 inches at the beginning of the week and gradually fell to 29·7 at its close. These quantities are, be it remembered, the result of observations at Greenwich, and taken about 150 feet above the mean sea-level. Meteorological observations in the centre of London are not recorded with any systematic care, but we may feel tolerably sure that the temperature in London was slightly higher than at Greenwich; that even less sunshine was recorded, and that the rate of movement of the air was even less and amounted to downright stagnation.

The characteristics of the air during a fog are, then, *darkness*, *coldness*, *dampness*, and *stagnation*. It appears probable (although I know of no exact observations) that the mobility of the air and the diffusibility of its component gases is diminished during a fog. One of the often-recorded phenomena of a fog is the way in which it remains stationary in banks, and with exact limits (forming real pillars of cloud), for hours at a time; and one must take it for granted that the products of respiration and combustion are not easily removed in such circumstances, but remain to irritate, and perhaps to poison, those who are surrounded by such envelopes of vapour. It is this stagnation of the air which, I believe, constitutes one of the great dangers of a fog. In estimating the effect the fog has upon the health and comfort of those who are immersed in it, a very important matter is its *duration*. All fogs, and especially London fogs, which are laden with irritative and infective particles, are very trying to sufferers from lung disease, especially those affected with chronic bronchitis, and the danger to these persons may be looked upon as proportioned to the length of time they are exposed to adverse circumstances. If the fog, after a few hours' duration, clears up, the lungs get rid of the irritating matter, respiration becomes normal again, and the patient is able to withstand a second bout of fog when it returns; but if a fog continues for a few days instead of a few hours, there is no respite, and the patient succumbs. One may compare Londoners in a fog to fish in a bowl, who suffer from the neglect of their owner to change the water; and it is evident that the longer the change be delayed, the more unfitted the water becomes for the respiration of the fish, and the greater is the danger. So the danger of a fog increases with its dura-

tion, for not only do the dwellers in it get no respite with which to obtain, as it were, a new lease of life by even a few gasps in the fresh air; but the dense fog-bank which weighs upon them gets hourly fouler and fouler from the products of combustion and the smoke (a result of non-combustion) from thousands of chimneys and the respiratory and other impurities from millions of men and animals. A very noteworthy feature of the fog of Christmas, 1891, was its duration: it began on Monday evening, and lasted, in a very dense form and without intermission, until Friday night; so that the time during which Londoners had to endure this weather—this mixture of coldness, dampness, foulness, and stagnation—was close upon a hundred hours.

When we come to consider what effect this long-continued fog had upon the health of London, we find that we have many facts to take into consideration before we can arrive at any conclusion. The effect of cold and fog upon the death-rate is produced almost immediately, because there is always a large number of sufferers from chronic maladies who are ripe for departure so soon as the first adverse circumstance arrives to overtax their feeble powers. Of course there are many others who do not die at once, but whose condition is so aggravated by the fog that they succumb in a few weeks or so. When fog and cold set in on a Monday some of the results of it would certainly appear in the death returns furnished to the Registrar-General on the following Saturday night, but as in this particular week Christmas Day fell upon a Friday, the work of Registration was upset, and many of the deaths occurring in the week, ending December 26, were not registered until the following week, ending January 2. It thus follows that in order to estimate the effects of the fog we

must take the deaths occurring in the *fortnight* ending January 2, and in this way we eliminate the disturbing influence of Christmas.

The estimated average number of deaths for the weeks ending December 26, 1891, and January 2, 1892, respectively, is stated by the Registrar-General to be 1,813 and 1,915, giving a total of 3,728 for the fortnight. The actual number of deaths registered in these two weeks was 1,771 and 3,399, giving a total of 5,170 for the fortnight, or an excess of 1,442. The excess of actual deaths in the week ending January 2 over the calculated average was 1,484, so that we may, in considering the details of the excess for the fortnight, limit our attention to the second week alone. To do so will save much trouble, and will not materially influence our conclusions. The death-rate for the *fortnight* averaged 32, and for the two weeks respectively it was 21·9 and 42. Limiting our attention to the second of the two weeks, we find that the following causes of death show a marked excess over the average:—

	Average	Actual
Measles	72	154
Whooping-cough	66	180
Phthisis	182	258
Old age	66	90
Apoplexy	50	79
Dis. of the circulatory system	154	317
Bronchitis	344	927
Pneumonia	120	253
Other respiratory diseases	51	120
Accidents	58	118
	1,163	2,496

It is noticeable that the excess of deaths is mainly attributable to lung diseases or zymotic diseases, such as whooping-cough and measles, in which lung complications are very common. Deaths from circulatory disease

were also far above the average, but as anything which hampers the action of the lungs must exercise a baneful influence on the circulation, this is what one would naturally expect, and merely tends to strengthen the assertion that cold and fog kill primarily by their effect on the lungs.

The death-rate for the whole of London was 42, while the death-rates for the several districts were as follows:—

Northern	36·4
Western	43·68
Central	52·0
Eastern	47·32
Southern	39·52

It is noticeable that the western districts suffered more than the northern or the southern, which is not to be wondered at, for, with the slight airs from the east which prevailed, the western districts would get the full effect of the foulness which drifted from the whole of the metropolis lying to the eastward. The highest fog death-rate was in the central district.

Bacteria

The evils of overcrowding have been made more plain and comprehensible by the discoveries which have been made in the science of bacteriology. When the public hears that a new microbe has been discovered in connexion with this or that disease, it says: 'Now, surely we shall have a cure.' It may be well to point out that, hitherto, in few cases of general disease has the discovery of a microbe led to the discovery of a cure; and the evidence that the study of the life-history of pathogenic microbes is likely to lead to the discovery of 'cures' is, to say the least, not very strong. 'Prevention,'

however, is better than 'cure;' and it is clear that the study of the life-history of pathogenic microbes must precede all adequate measures for preventing the diseases which they cause.

It was the study of the life-history of the microbes which produce putrefaction which led Lord Lister to adopt the antiseptic treatment of wounds which has produced such grand results. The knowledge that cholera and typhoid poisons can live in water has led to great caution in the selection and protection of water-supplies, and it is possible that the time is not far distant when we shall regard the wilful mixing of excremental matters with water as, in a sense, an act of public suicide. Again, the knowledge that typhoid fever, diphtheria, and scarlet fever are often connected with the milk-supply has been the means of arresting many an epidemic. In short, the medical profession has no cause to feel ashamed of its recent progress in the direction of prevention of disease, which, in the words of Sir William Jenner, should be the great aim of a physician.

While certain diseases reach us *via* water and food, there are others which come to us in the air we breathe, and it is well to bear in mind that it is in relation to air-borne diseases that overcrowding is especially dangerous. Whooping-cough, measles, scarlet fever, diphtheria, tuberculosis, typhus fever, small-pox, influenza, pneumonia, and plague, and, to a less extent, typhoid fever, are among the diseases which are air-borne, and the spread of which is, in a very obvious way, favoured by overcrowding. It is definitely known with regard to some, and may be safely inferred with regard to all the above-named diseases, that the carriers of the infection are particulate and alive. A sufferer from any one of these diseases is continually giving off infective particles,

and the danger of the infection travelling to a second person depends (1) upon the distance of the second from the first; (2) the ease with which the infected air can be diluted with fresh air. Thus the danger caused by proximity to an infected person in the open air is comparatively slight, because the chance that the infective particles will be blown away by the wind is very great. When, however, the infected and the healthy come to live under the same roof, to occupy the same room, and, still more, the same bed, the risks of infection are enormously increased, because the air in the confined space gets very largely charged with infective particles which the healthy can hardly avoid taking. Given the rate of movement of the air, the degree of proximity of the individuals, and the number of infective particles given off by the diseased person, and the risk of infection could be stated as a mathematical formula. There is good reason to believe, however, that the mere fact of overcrowding produces some change (possibly chemical) which greatly increases the risks of infection, apart from the mathematical factors above alluded to. Some of the facts connected with the recent epidemic of influenza bring out very clearly the increased danger of infection which results from overcrowding between walls and under a common roof.

Overcrowding is seen at its maximum in the forecastle of a ship after the men have 'turned in,' and the danger to all, should any case of infective disease be present among them, is well known. The explosive outbursts of influenza which are liable to occur on board ship have been amongst the startling features of every epidemic. In the same way explosive outbursts of the disease have occurred in establishments where many persons have a common employment under a common

roof, as witness the sudden occurrence of a thousand cases at the end of 1889 in the Magasins du Louvre at Paris, and a similar outburst at the General Post Office in January 1890. A careful consideration of the whole of the facts of the epidemic of 1889–90 leads Dr. Parsons, in his report made to the Local Government Board, to conclude:[1] '8. That in public services and establishments persons employed together in large numbers in enclosed spaces have suffered in larger proportion than those employed few together or in the open air. 9. That in institutions in which the inmates are brought much into association the epidemic has more quickly attained its height, has prevailed more extensively, and been sooner over than in those in which the inmates are more secluded from one another.' The converse is also true, for Dr. Parsons states that those living away from the possibility of infection and in small groups, such as lighthouse keepers and deep-sea fishermen, enjoyed a remarkable immunity from the epidemic. It must be remembered that what is true of influenza is also true of other air-borne infections. It is known that whooping-cough and measles are prevalent and fatal, very much in proportion to the density of population on a given area, and it has lately been shown that, although the mortality in so-called model dwellings is below that of the working-class dwellings as a whole, the occurrence in them of infantile infectious diseases, including diphtheria, is distinctly above the average. This is not to be wondered at, for with a large number of persons under a common roof the risks of infection must be proportionate to the number of inhabitants.

[1] See p. 101 of the *Report on the Influenza*.

The Modern City

The modern city is distinctly a modern invention; it had no counterpart in ancient times. The ancients crowded behind walls from fear of their enemies. The modern city has no walls and no need of them, and there does not seem to be the same necessity for overcrowding that there was in the ancient city. As a matter of fact, however, the modern city both here and in America exhibits a degree of overcrowding on space such as, I believe, has never existed in the history of the world. The main cause of the difference between the ancient and modern city is the possession *of water under pressure.* In ancient Rome an excellent supply of water flowed from the neighbouring hills along open aqueducts supported on arches, and it is probable that the greatest head of water to be found in ancient Rome was represented by the height of the aqueducts above the level of the ground. Most of the buildings in ancient Rome were what we should consider low. The dwelling-houses were rarely more than one storey, or two storeys, high, and it was only in public buildings—temples, baths, basilicas—that an attempt was made to carry the edifice to any great height. In mediæval cities, three-storeyed buildings represented the average maximum, for without water under pressure very high buildings were impracticable, owing to the labour of carrying water to the upper storeys and the difficulty of removing refuse. Formerly a house was scarcely habitable unless it had a courtyard of some kind. This was essential for sanitary purposes —for a well and for the bestowal of refuse pending its removal by the scavenger. Most of the decent houses in mediæval London had a considerable amount of curtilage as may be seen by consulting the maps of Aggas, Ryther,

Newcourt, and others. The steam-engine and the cast-iron water pipe have together created a new order of things. The steam-engine gives us any head of water we desire, and the modern iron fittings are able to stand any pressure to which we may find it necessary to subject them. There is no longer any difficulty in taking water to the top storey of any house, however lofty; no longer any difficulty in washing the filth out of any dwelling-house, however big; there is no longer any absolute necessity of limiting the height of buildings; no longer need of any curtilage to a house, nor for any outlet other than a pipe. This, indeed, is magical. 'My estate,' says one, 'has risen in value from 100*l.* an acre to 5*l.* a foot.' 'My water shares,' says another, 'pay me 12 per cent.' 'My mansions in the sky,' says the builder, 'have sold for double what they cost me.' All the gas shareholders and those who have invested in electric supply companies join in the chorus of delight. This is, indeed, a civilising and wonderful age. Let us build a temple, and place in it a steam-engine, an iron water-pipe, and an hydraulic lift. Under these very money-making conditions it is not to be wondered at that the craze of the present time is for tenement houses, which are called model dwellings, flats, or mansions, according to the class for which they are intended. Whatever they may be called they are all of the same type, and they are calculated to trouble the soul of the sanitarian who knows the danger of overcrowding on space and under a common roof.

Let us hear what Edinburgh can teach us on this subject. In a very excellent paper on the Hygiene and Demography of Edinburgh, which was communicated to the seventh (London) Congress, and which is now published in the twelfth volume of the Transactions of the

Congress, is (p. 66) the following passage: 'Edinburgh enjoyed for many years the unenviable notoriety of being subject to periodical outbursts of fever. These assumed in all cases the epidemic form, and entailed a large mortality on the citizens. . . . . There can be no doubt that one main cause of these repeated outbreaks was the manner of housing the inhabitants, which, copied from the French, consisted in piling tenement above tenement until a large overcrowded population was confined in a limited space, and could only communicate with the outer world by a narrow stair. . . . . When infectious disease of any kind broke out in such circumstances, it spread with great rapidity, and quickly assumed the epidemic form.' It is doubtless gratifying to national vanity to have a capital city composed of huge edifices which may be made to look palatial from the outside, but there is also no doubt that the comparatively low death-rate which London has hitherto enjoyed is to be attributed to the fact that as a rule each family has had a house of its own. It is strange that the craze for high buildings has reached its maximum in America, where cities have sprung into sudden existence on the boundless prairie, where space is practically unlimited. The main causes of this seem to be hurry, avarice, an insane spirit of competition, and the difficulties connected with domestic service in a country where the citizens are more willing to slave for a machine than to serve a mistress. Life in hotels and boarding-houses is more common in America than here, and co-operative housekeeping has reached a high state of development. Water, heat (by steam coils), gas, electricity, telephones, and hydraulic power are supplied to groups of houses from common centres. This is a convenient arrangement, but one which makes for the overcrowding of houses on space.

Domestic architecture is in danger of becoming a lost art in cities where the inhabitants are content to be stored in human warehouses erected by engineers and as full of machinery as a factory. In the most modern city in the world (Chicago), the builders of which have had the opportunity of avoiding all the errors of the past, it is curious to note that the engineer-architects have exceeded all previous efforts in the matter of high buildings and overcrowding. The 'Masonic Temple' in Chicago has twenty storeys and is 265 feet high, and is merely the latest and worst of many similar buildings in the city. In such a city the sewage difficulty is necessarily very great, but we learn that a special canal is to be constructed for its reception, and this is to discharge into the upper waters of the Mississippi! It seems astounding that such an outrage on their noblest river should be tolerated by the American people. The volume of the sewage may be as nothing when compared with the volume of the river into which it is to be discharged, but one would ask, Can this ingenious race, which likes to be considered in the van of progress, do nothing better with the sewage of a great city than this? And are we to conclude that their hygiene is founded more on expediency than on any true scientific, economic, or moral principles? As regards the state of public health in Chicago, the following figures may help one to form an estimate of it. The annexed table, compiled from the official mortality returns, shows that for 1890 the death-rate was 18·2, and for 1891 22·2. It has not been possible to make any correction for age distribution, but it seems highly probable that Chicago is largely peopled by vigorous adult immigrants who crowd into it in search of employment. The zymotic death-rate was 4·09 in 1890 and

5·61 in 1891, the latter figure being not far from double the zymotic death-rate of London in 1890. The death-rate from typhoid fever was 840 per 1,000,000 in 1890 and 1,596 per 1,000,000 in 1891, the latter figure being nearly five times as great as the largest typhoid fever death-rate ever recorded in London. Croup and diphtheria in 1891 killed 1,087 per 1,000,000 in Chicago, which is a figure enormously in advance of any that have ever been recorded in London. These figures seem to show that no amount of ingenious engineering can counteract the evils of overcrowding on space.

Death-rate per 1,000,000 *Living*

—	All causes	Zymotic	Diphtheria and croup	Typhoid fever	Tuberculous affections	Respiratory affections	Violence
Chicago, 1890	18,214	4,090	1,051	840	1,859	3,136	1,069
„ 1891	22,204	5,610	1,087	1,596	1,967	4,089	1,170
London, 1890	20,978	2,896	330	144	2,943	4,910	719

It needs to be pointed out that the overcrowding of our cities, which is admittedly the greatest of all sanitary evils, is the direct result of sanitary legislation. When, some forty years since, it was recognised that water-carried sewage inevitably poisoned the wells, no attempt was made to protect the wells from pollution; but the surface wells were compulsorily closed, the inhabitants were sold in bondage to the water companies, and the houses were compelled to pollute our rivers. These measures have given a fatal facility for overcrowding, and wherever a line of sewers is taken the speculative builder follows; for, not being hampered by questions of water-supply or filth-disposal (the sanitary authorities relieving him of all responsibilities in this matter), he is able to erect buildings without any curtilage, and of any

height almost that he chooses. Be it observed that this state of things is not limited to London or the big towns. The notion that houses are as well without curtilage as with it has infected the country, as anybody may see for himself when travelling by railway. The train runs through miles of country, with scarcely a house to be seen; but when we stop at the developing district, growing up round the country station, we find the houses packed almost as closely as they are in the centres of towns. As an instance of this, a village might be mentioned where land can be bought at very little above its agricultural value. This village has been selected by a railway company for the establishment of 'works,' and the company has erected rows and rows of artisans' cottages with at most a few square feet of curtilage each. The onus of draining these cottages will ultimately be thrown on the local authority, with the additional onus, in a few years' time, of providing the inhabitants with allotments; and all the expense of this will fall upon the ratepayers as a whole. Clearly, the best place for an allotment is round the dwelling, and some compulsion should have been put upon this wealthy company to provide it. A couple of hundred acres of land (enough for 1,000 cottages) might, I believe, have been purchased in this particular spot for less than 10,000*l.*, and would have added 10*l.* to the cost of each cottage. What is this to a rich company, especially if it be the means of increasing the health and contentment of their work-people? Would it not be money well spent, and spent to the ultimate advantage of the shareholders? We have engendered a stingy habit of mind towards the question of space round houses, which almost amounts to a national insanity.

A country town which the writer knows well, where

200 acres of land with a house and farm buildings recently sold for 4,000*l*., has sanctioned the erection by a building society of 200 dwellings on six acres of land This building estate will, if successful, have a population of 1,000 persons, or nearly 170 to the acre, a degree of overcrowding about three times as great as that of the average of London. The building society will make a good profit, while the sanitary authority which sanctioned this scheme will ultimately have to deal with the infectious diseases of this crowded area, and will not only have to provide, at the expense of the ratepayers as a whole, for the safe bestowal of the filth from this area, but will also, possibly, be compelled to provide the tenants with allotments.

Can anything be worse from the hygienic point of view than the modern tenement house or monster hotel, where each floor ventilates into the floor above and the floor below, while the 'lifts' effectually drive the air from one floor to another without renewing it? In such places, where hundreds live under a common roof, fresh air is impossible. Dr. Ogle, in his paper on 'The Relation of Occupation to Disease and Mortality,' has pointed out that the mortality of hotel servants is higher than that of any other class, being nearly four times as great as that of the clergy, who enjoy the lowest degree of mortality. This high mortality is not to be wondered at, for the hotel servant never breathes fresh air, and lives day and night in an overcrowded dwelling redolent of humanity, dinners, gas, tobacco, and drains, one or all, most commonly all. Alcoholism may have something to do with this high mortality, but we must all admit that the unwholesome conditions of life are probably the main cause of alcoholism. Drinking is said to be on the increase in this country, and it is probable that

it would be found to bear a very definite ratio to the overcrowding on space. The advantages of hotel life are many, and the charms of living in a pleasant community are very great. These charms have always been recognised, but when we contrast the 'college,' as seen at Oxford or Cambridge, with its ample area and the opportunities for society or seclusion at will, with the modern hotel, raised tier above tier, in which tranquillity and fresh air are alike unknown, it must be confessed that, æsthetically and hygienically, the mediæval architect was ahead of his successors. These remarks apply not merely to those great hostelries in cities, where persons are content to jostle each other during a short paroxysm of business or pleasure, but also to establishments erected in health resorts and by the seaside, which have been designed for the reception of delicate persons and invalids, and which are well calculated to bring chronic maladies to a termination.

The Economic Point of View

Let us look at the question of overcrowding on space from an economic point of view. It is calculated that to raise the body vertically requires twenty times the force necessary for walking on the level, so that whether we mount stairs to the height of 100 feet or walk 2,000 feet along the level the labour is the same. But I shall be told there are 'lifts,' and, that being the case, it becomes quicker and easier to move vertically than horizontally. It costs money to be carried, however, and a 'lift' is a most extravagant machine, because it does not accommodate the force expended to the weight to be raised. In a report issued by the South London Electric Railway, it was stated that the cost of

working the lifts is 10 per cent. of the gross receipts! We are becoming alive to the fact that the fogs of London are getting more frequent and more virulent, in spite of the steady increase in the use of gas as a fuel. This is due to the overcrowding of houses and the multiplication of chimneys on a given area. In the country, and in most towns, the smoke is diluted to a point which practically gives us no trouble. It need hardly be said that a house of nine storeys will give off three times as much smoke as one of three storeys having the same area. In the centre of London we have been building enormous piles of offices and tenements, adding storeys to old houses, and putting buildings upon every garden and back yard, while at the same time the area of the city has enormously increased. What right have we to grumble at the increased density of the fogs? We have deliberately caused it, and neither Royal Commission, parliamentary committee, nor anthracite coal will put it right. Even though we got rid of the 'blacks,' we should still have the irritating invisible products of combustion—by far the most harmful of the elements of a fog—to deal with. We have made our bed, and we must lie upon it. The damage done to property by fogs, the extra cost of washing and painting entailed by living in the dirtiest capital city in the world, the serious loss of trade, the cost of using artificial light in the day-time, as well as the injury to health, must be all reckoned as among the penalties we pay for overcrowding. 'Cleanliness is next to godliness,' says the old adage, and we are bound to admit that the filthiness of the air of London is a not unimportant factor in causing the moral degradation in which not a few of the inhabitants are sunk.

One main object of overcrowding houses is the saving

of time in the transaction of business, but there are limits which cannot be overstepped without defeating our object. The check put upon freedom of locomotion by overcrowding, and the time occupied in going from point to point, more than counterbalance the shortness of the distance which we have to travel, to say nothing of the fact, previously alluded to, that vertical movement requires twenty times the force of horizontal movement. In London rapid locomotion is getting daily more and more impossible, and there are so many vehicles and persons in the streets that we are all in the way of one another. Our streets are always more or less blocked by building operations, which must be in proportion to the cubic contents of the buildings on a given area. Then, again, we have beneath our streets sewer pipes, water pipes, gas pipes, hydraulic power pipes, and pneumatic tubes, as well as wires for telegraphs, telephones, and electric lights. The necessity for interfering with these various subterranean arrangements in any one street must be largely proportionate to the number of dwellers whose front doors open into the street. These being almost unlimited, it follows that our streets, instead of being only occasionally 'up,' as the phrase goes, are only occasionally 'down.' Again, the number of vehicles which stop at any given door is proportionate to the number of persons who live behind it. A set of 'mansions' with 200 inhabitants may have scarcely more frontage than a modest house accommodating ten persons, but the vehicles stopping at them will be twenty times as many. It is the halting vehicles rather than the moving ones which offer the greatest obstacles to traffic. In civilised London we have very few back doors; our coals are shovelled in and our garbage hauled out under the dining-room windows; and these

tedious operations, performed in the main thoroughfare, are in themselves great obstacles to traffic. The wear and tear of the streets is in proportion to the traffic, and in some of the leading thoroughfares the traffic has become so great that it is wonderful that any material can be found hard enough to stand it. These considerations make it clear that the increasing difficulties of locomotion in London are due to the overcrowding of houses on a given area.

From the æsthetic point of view the effects of overcrowding are disastrous. Proportion is one of the most important elements in architectural beauty, and few will be found to admire the Gargantuan architecture of the engineer-builder.

In spite of a somewhat dull uniformity, Regent Street still remains the finest street in London in virtue of its outline and proportions and the possibility of sunlight getting access to it. Contrast Regent Street with Northumberland Avenue, that drafty, gloomy gorge of bricks and masonry, in which the only really pretty building is the cabmen's shelter at the end. It is mere waste to erect fine buildings in situations where they cannot be seen without effort. Every good building ought to have a proper 'setting.' How would Westminster Abbey look without its greenery and turf? Can any building look really well without some verdure or floral decoration? Can any building that has them look really ill? In London our buildings are getting too high for their confined situations; they block out the sunlight, their many chimneys foul the air with soot, and, as a consequence, our palaces are grimy, and gardening, the most beautiful and the most health-giving of all arts, has become impossible. Wandering in the streets of London, and looking at the dim outline

of our grimy public buildings looming through the mist, one is reminded of the lines from the opening of 'Macbeth:'—

> **Fair is foul, and foul is fair:**
> **Hover through the fog and filthy air.**

When the air of a city gets so foul as to hinder and arrest vegetation, we are hygienically in a 'parlous' state, as Touchstone would have said. Not only do the green leaves of plants absorb carbonic acid from, and give off oxygen to, the air, but their roots are no less useful in draining and purifying the soil upon which we live. We have heard a good deal about the dangers of an impure soil, and the invariable advice with regard to it is to put something which is impermeable, such as concrete or asphalte, to prevent the rising of possible impurities from the earth. This is analogous to putting dead bodies into impermeable coffins, whereby the danger of their decomposition is not prevented, but merely delayed. The only way to purify the soil is by cultivation, aeration, and the growth of plants. I believe that an evergreen creeper, such as ivy, does more to keep the foundations and walls of a house dry and pure than do any of the patent impermeable applications.

As London, in spite of all its 'betterments,' is getting steadily less habitable year by year, there is very properly a growing tendency to sleep out of town and journey to and fro business. Not more than 28,000 people sleep in that square mile which we call 'the City;' but as more than 300,000 find permanent daily occupation there, it is obvious that there are some 270,000 daily workers who have to be transported to and from the suburbs. If we reckon cost and loss of time in transit, it will not be an extravagant estimate to suppose that this journeying involves a loss of one shilling per head

per diem, or, collectively, 13,000*l.* a day, 78,000*l.* a week, and over 4,000,000*l.* per annum. When a man lives out of town he becomes a slave to a railway company, he has to be punctual himself in order not to miss trains which are seldom punctual, and he finds out what it is to bear 'the whips and scorns of time.' As he wastes his time in being shuttled to and fro he must be queerly constituted if he does not wish for the good old times when it was possible to 'live over the shop.' Our modern facilities of communication cause us to be always in a hurry, and it is certainly a suggestive fact that having invested nearly 1,000,000,000*l.* in railways, on which we go shrieking to and fro; having so perfected the penny post that it has become a veritable nuisance with its endless delivery of documents, which are mainly worthless waste paper in the form of advertisements; having annihilated time and space by the telegraph and telephone; and having abolished darkness by means of gas and electricity—there should arise an ominous cry for a limitation of the hours of labour and a demand to do by Act of Parliament that which, 'in the good old days,' the sun did for us.

There is yet another consideration which shows the cost of overcrowding houses. When growth occurs in an organised body, such as a tree or an animal, all parts increase *pari passu*, and there is no necessary loss of health or vigour. But in a city growth is more like an inflammatory swelling, the cells of the part increase, while there is no adequate increase of the channels which bring nutriment. Stasis is apt to occur, and unless relief be given by surgical means the death of the part will follow. The modern city is ever in need of surgical interference; new thoroughfares have to be cut in order to give relief to congested districts, and these operations

can only be carried out by means of an expenditure of money which is simply appalling in amount. The attempt to improve the sanitary state of a city by a process of 'Haussmannising' must be futile. If we make a fine boulevard through the slums the inhabitants are merely piled in heaps on either side; the width of the street is increased by increasing the overcrowding of inhabitants under a common roof, which is the greatest of all sanitary evils. Not long since a scheme was foreshadowed in one of the magazines for turning the Euston Road into a boulevard by appropriating all the front gardens and back yards, and erecting huge tenement houses on either side. No proposition could be worse from a sanitary point of view. It cannot be too earnestly insisted upon that the air of the grimiest back yard is better than that of any room, even though its (generally closed) windows command a view of a stately boulevard. The breathing of fresh air, so important to all, is doubly important to very young children. Children under four are too young to play in the streets; their mother's home duties are too arduous to allow her to take them to the park, and the little girl who might do so has been driven to school by the law. The result is that the little children have to breathe the fetid air of a small living room from week's end to week's end, instead of being able to play in a little yard, where the mother could watch them through the open door, as formerly was the case. The value of an open space is largely in proportion to its proximity to the dwelling. A little back yard or garden of one's own is worth infinitely more than Hyde Park a mile off, and the old graveyard converted into a garden a hundred yards down the street is far more precious to the poor town dweller than Epping Forest or Burnham Beeches.

The overcrowding of houses means loss of liberty, for the closer we crowd together the more likely we are to suffer from the sanitary negligence of others, and the more necessary does it become to regulate our actions by by-laws and Acts of Parliament. I need hardly insist on the fact, so ably enforced by Herbert Spencer, that personal liberty is necessary for social evolution, and that Acts of Parliament are evils only to be tolerated for the avoidance of greater evils. The growth of Acts of Parliament of late years, and the new offences which they constitute, was recently forcibly pointed out by the chief constable of Liverpool in a letter to the *Times*, in which he stated that in 1890 there were as many as 11,279 cases in Liverpool under the Education and Health Acts alone. Overcrowding has necessitated the compulsory notification of disease and the appointment of a crowd of inspectors, and there are those who wish to compel us to take out a licence for our houses, which is only to be given when they are fitted with the particular sanitary apparatus which happens to be in fashion. It is well to bear in mind that the overcrowding of which I am complaining is largely the result of compulsory Acts of Parliament which curtailed our liberty in the matter of water-supply and sewerage, while they gave to the speculative builder opportunities by which he has not failed to profit. When a couple of years since the influenza made its reappearance among us, a distinguished engineer wrote to the papers with the kindly object of comforting us by the assurance that the perfection of our sanitation would certainly lessen the ravages of the epidemic. It need hardly be said that the author's opinion was directly opposed to his, for influenza being an air-borne disease, and the overcrowding of houses and the fashion of many families living under a common roof

having largely developed since its last appearance, it seemed probable that the epidemic would be more severe than formerly, and more difficult to eradicate.

Remedies

Can nothing be done to check the overcrowding of houses and persons? Although we have passed many laws for the improvement of the public health, we have not sought as yet to put any very severe restraints on the builder and landowner, and we have not sought, as would seem but reasonable, to limit the number of inhabitants who may be accommodated on a given area of land. It is the object of all traders, whether they be public companies or individuals, to have the largest number of customers on the smallest possible area, and therefore any attempt at restriction cannot be popular. Neither would such restriction be popular with the sanitary authorities, who have to collect rates; for rateable value is unfortunately directly proportionate to the overcrowding of houses on a given area.

Building Regulations

Part V. of the London Building Act, 1894, provides for open spaces about buildings and height of building.

It provides, in the case of new houses in new streets, for an open space in the rear, exclusively belonging to such building, of at least 150 square feet, free from erections except w.c. and ashpit. Where the ground storey is not inhabited, this open space may be provided at a height of 16 feet above the level of the pavement. The open space must extend the entire width of the building and have a depth of 10 feet at least.

A diagonal line drawn from the rear of the open space

on the pavement level, and inclining towards the building at an angle of 63°·5, shall clear the top of such building save chimneys, dormers, gables, &c. This means that the house may be at all levels twice as high as the space is deep.

When a house abuts at the rear on a street or permanent 'open space,' then no private open space or curtilage need be provided.

'Nothing in this section shall apply to houses abutting in the rear on the river Thames, or on a public park, or on an "open space" of not less than 80 feet in depth which is dedicated to the public, or the maintenance of which as an open space is secured permanently or to the satisfaction of the Council by covenant or otherwise.'

In new streets less than 50 feet wide no house may be erected having a height greater than the width of the street.

No house may be more than 80 feet high without the special permission of the Council.

These regulations, from the point of view of health, are as bad as can be, because they put a premium, so to say, on buildings of enormous cubic capacity. We have seen that the provisions as to private curtilage are limited to a back yard 10 feet deep, but in the case of houses abutting on two streets, front and back, or abutting on a street and 'open space' 80 feet deep, these restrictions are dispensed with.

If an open space, acquired and maintained at enormous cost, is to be an excuse for surrounding it with huge blocks of 'flats' 80 feet high, it is not difficult to see that their effect on the public health will be mischievous rather than beneficial. There is no advantage in looking out on an open space through a closed window,

and the great problem in London is how to manage that young children under school age are to breathe the external air, which is essential to their proper development. In the country the perambulator is pushed into the garden, and through the open door the mother at her work can have an eye upon her children. But for a family occupying a set of rooms in a 'model dwelling,' when the father is gone to work, the elder children at school, and the mother busy, there is nothing for it but to allow the children to breathe the air of the living-rooms, fouled from many sources. These children seldom breathe external air, and never breathe really fresh air. When they are a little older, they fluctuate between crowded two-storeyed schools, a fetid home, and an 'open space' (perhaps 80 feet wide and surrounded by houses 80 feet high!) Is it to be wondered at that the even tenor of their way is interrupted by diphtheria and scarlet fever, or that 22 per cent. die without ever keeping a birthday, and that children under five are more than decimated annually?

I shall be told, and rightly, that the horrible overcrowding of houses in the centre of London is caused by the high price of building land, and that it cannot be prevented. Further, I shall be told that, in spite of the overcrowding and general unsanitary conditions, rents are increasing. This is also true as regards some districts, but there is no relation between hygiene and money-getting. There is no reason, however, why we should deceive ourselves as to the results of overcrowding. They are set forth with absolute plainness by the Registrar-General.

I have for years combated the oft-repeated statements as to the 'healthiness' of London, not because I expect that London will alter its way, but because rural places

and the Colonies should not blindly follow the lead of London, in the belief that they are following a good sanitary model, and that disastrous consequences will not inevitably follow upon a reckless overcrowding of houses.

The prime object of overcrowding was for safety. Cities were originally walled fortresses, and people crowded into them for protection, and were killed by epidemics instead of by their enemies. Modern sanitation favours overcrowding, and this it is which makes it so popular, for overcrowding favours money-getting.

When sewer pipes and water pipes are laid throughout a district it becomes possible (but not till then) to build houses without curtilage, except a 10-foot back yard.

If, therefore, rural places are reckless enough to perpetrate a 'sewage scheme,' it becomes very necessary to check the overcrowding of houses.

'Model' (!) By-Laws

I am sorry to say that the Local Government Board does not appear to be sensible of this necessity.

My reason for this statement is (to quote an example within my own knowledge) that the Local Government Board sanctioned the adoption of 'model' (!) by-laws by a rural borough, and on examining these by-laws, which cover 69 closely printed large octavo pages, and comprise hundreds of sections and sub-sections, the bulk of which must be quite incomprehensible to the town council, I find that as regards buildings many of the clauses are practically identical with those of the London Building Act.

The Local Government Board does not seem to

recognise that circumstances alter cases, and that the regulations which may be beneficial in the crowded and filthy slums of a great city may be mischievous in a village or country town. The town alluded to is exceedingly healthy, and in it there must be very few, if any, houses more than 50 feet high, and the great majority of the houses and cottages have large yards or gardens.

And yet the Local Government Board sanctions regulations for this town which permit the erection of dwelling-houses a *hundred feet high ! with a back yard* 25 *feet deep* ! ! and it further allows the adoption of the minimum of 150 square feet of back yard for dwelling-houses.

In illustration of this, reference may be made to figs. 2, 3, 4, which are borrowed from Knight's 'Model By-laws,' published under the authority of the Local Government Board. Fig. 2 shows the 'model' open space for a cottage, fig. 3 for a house up to 25 feet high, and fig. 4 the maximum which is necessary, even though the house be 100 feet high or more.

These regulations may be good in London, but when such regulations are printed in the by-laws of rural places they become dangerous suggestions, which one fears the local builders will not be slow to adopt.

These elaborate building regulations as applied to country places are absurd. I do not say that in the case of houses abutting on the streets and which touch other houses some control by the local authority is not necessary, or that the local authority is not to exercise supervision as to the manner of making connections of houses with sewers, water pipes, and gas pipes.

But it is clear that all harassing regulations are out of place when they are applied to isolated dwellings

which are wholly detached and separated by a moderate interval (say a distance equal to the height) from the

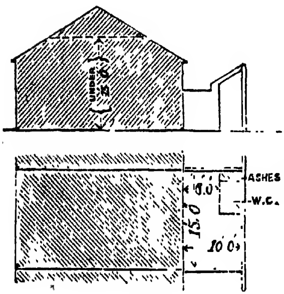


FIG. 2.

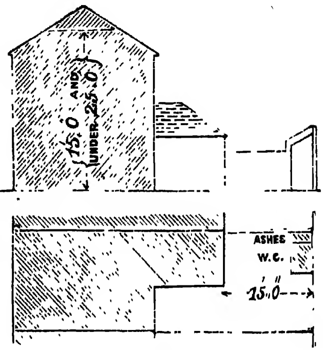


FIG. 3.

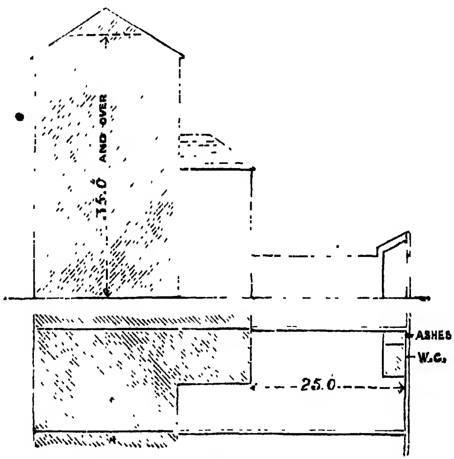


FIG. 4.

boundaries of other premises. The man who builds a detached house ought to be encouraged, and not worried,

and the insurance offices and the owner may be left to see that the construction of the house is good enough.

These by-laws contain a prohibition of overhanging storeys (in the old English fashion), which may be reasonable enough in crowded streets, but are unreasonable and silly when applied to isolated dwellings. A friend of mine had a fancy to build a house of this kind in the middle of three acres of land which he bought in Hertfordshire, and after he had been at the expense of getting out his plans, &c., he found that such a building was *against the by-laws*. However, he discovered means to overcome the objections, and his very pretty house was built, and is a decided ornament to the district.

These by-laws are an expense to ratepayers, and they increase the cost of buildings. Elaborate plans and descriptions have to be furnished, and the buildings have to be inspected at various periods of their construction, and, of course, all variations of plan which may appear necessary in the course of construction must also be submitted and 'passed' by the local authority. It may happen that there are members of the local council who understand the technicalities of the building trade; but even if this be the case, it is manifestly unjust that the plans of a builder who is outside the council should be submitted to and judged by a competitor who happens to be inside. As a rule, the council is completely in the hands of the local surveyor, and the local surveyor exercises despotic power over all building operations.

These arbitrary by-laws must tend to check building operations, and to hinder the development of the art of the architect and the science of the builder. The restrictions are an instance of

> Art made tongue-tied by authority,
> And Folly, doctor-like, controlling skill;

and I feel certain that, in the interests of public health, builders of isolated dwellings ought to be allowed to escape.

Everything which tends to encourage the provision of adequate space round dwellings is a great gain.

Such by-laws as I have quoted, when applied to country places, and when no exceptions such as I have indicated are made, are a downright incentive to overcrowding, and mischievous in the highest degree.

The Cost of the Dwelling

Everything which increases the cost of the dwelling must tend to increase overcrowding.

The London rents are enormous; the artisan pays 7*s.* or 8*s.* for accommodation which he could get in a village for 1*s.* 6*d.*, and in a country town for 2*s.* 6*d.*

The rich man pays his 200*l.*, 300*l.*, or more for a house (without a square inch of curtilage) which out of London would fetch 40*l.* or 50*l.* at most.

In London it happens, probably, more often than elsewhere that people pay in house-rent a sum which is an excessive proportion of their income, and their finances feel the strain of slight increments to the cost of the dwelling, and they are often driven to take lodgers or 'paying-guests;' or people apparently well off give up their houses and take a 'flat,' in which the crowding is excessive.

This kind of thing goes on among the well-to-do classes, and certainly to a greater extent among the poor.

When we consider the charges, other than rent, in London as compared with country houses, we must never forget that, rents being three or more times as

high in London as elsewhere, the rating in the pound ought to be multiplied by three or four before we can compare London rates with country rates.

Or we must take some other basis of comparison, such as the area occupied or the cubic contents. A house which I lived in in London for twenty-five years occupied an area of 18 by 72 feet, or 1,296 square feet, or 144 square yards.

The rent was originally 180*l.*, which was raised to 200*l.* when the lease was renewed in 1892, and to 250*l.* when it was sublet in 1897; *i.e.* the rent was originally 1*l.* 5*s.* per square yard, and is now 1*l.* 14*s.* 6*d.* per square yard. 'The rateable value' has been gradually pushed up, and the gross value has lately been put at 10 per cent. more than the rent (because the tenant undertakes to do the repairs).

The changes other than rent have been as follows:—

—	1873			1896			1902		
	£	s	d.	£	s.	d.	£	s.	d.
Income tax . . . . / Inhabited house duty .	9	15	0	14	18	4	25	18	9
Parochial rates . .	30	0	0	55	19	4	77	12	6
Water	6	8	0	7	10	6	8	4	4
Total	46	3	0	78	8	2	111	15	7
Rent	180	0	0	200	0	0	250	0	0
Grand total . . .	226	3	0	278	8	2	361	15	7

Thus it will be seen that the cost of this house (which has not been enlarged in any way) has been increased by 60 per cent. The rent has increased nearly 40 per cent., or 70*l.* a year. The rates have increased by nearly 157 per cent., or approximately 48*l.* a year.

The imperial taxes have increased nearly 166 per

cent., or 16*l*. 8*s*. per year, and the water by nearly 28 per cent., or 1*l*. 16*s*. per year. It will be noted that while the tenant in this case submitted to an increase of 40 per cent., the charges over which the tenant has practically no control have increased in a much higher ratio, and now amount to 111*l*. 15*s*. 7*d*., or more than 15*s*. per square yard of occupied land, the total cost of the house being over 2*l*. 10*s*. per square yard, or, including repairs, nearly 3*l*. per square yard.

The total obligatory charges (rent, rates, taxes, and water), which in 1873 were 226*l*., had risen in 1902 to 361*l*.

The charge for water has been included because no house is habitable without it, and in this case the tenant cannot sink a well, because the house is totally without curtilage of any kind, and the rain-water having fallen through the London air is so foully dirty as to be unusable.

The householders of London rightly view with alarm the rapid increase of the sum levied for rates. This sum increased at the rate of more than 3 per cent. per annum during the twenty-five years I lived in the house I have been describing, and now amounts to rather more than 15*s*. per square yard occupied. The average householder is naturally nervous and apprehensive; he is getting unwilling to take a house for a long term, and is squeezing his household into 'flats,' in which (as the landlord pays the rates) the yearly expenditure on house accommodation is fairly calculable. The attractiveness of the flat is further enhanced by short-term leases, so that, should illness or a financial mishap befall him, he will be less heavily weighted than would be the case if he were the owner of a long, unmarketable lease.

I think we may take it for granted that if the well-to-

do classes are showing a tendency to overcrowd, this tendency will be found to get progressively more intense as we descend in the social scale. The well-to-do occupiers of flats have to be content with what may be called 'rather close quarters,' but their servants are often squeezed into rooms scarcely bigger than cupboards. It is not conceivable that those who are in a dependent position will have better accommodation than those whom they serve.

Remedies for Overcrowding

The final question is, What can be done to prevent overcrowding of houses and of persons in the house?

I freely admit that very little can be done in big towns, and people must be left to judge for themselves as to whether they will allow their children to run the extra risk of death, crippling disease, or defective development, inseparable from life in a crowded city. The statistics of the Registrar-General (*i.e.* the Annual Summary and the Decennial Supplement) show clearly what these risks are, but it is necessary to add that some of the local statistics manifest at times an undue desire to minimise the mortality of the district from which they emanate.

A great metropolitan city like London, concerning which we are educated from our cradles to utter big boasts, exercises an enormous influence on public opinion, but it is perfectly clear that she is a dangerous model to follow in the matter of house-construction.

I call to mind the case of a great London builder who bought a country mansion in a park. He was a very able man, but when he carried out some alterations and additions to his new house he found it impossible to cast away his town-bred ideas, and accordingly built under-

ground kitchens and coal cellars, and had the coals put into his cellar through a plate in the pavement just outside the drawing-room window. He had been so long accustomed to build houses with a minimum of area, that when he had an unlimited space at his disposal he failed to utilise or appreciate the advantages of such a boon.

Country places should be careful to avoid the adoption, as by-laws, of regulations originally framed with the idea of mitigating the horrors of the London slums. With regard to these regulations, it must be remembered that 'the trail of the Cockney is over them all,' and it has been shown that regulations, especially as to space round dwellings, which may be beneficial in the Seven Dials become mischievous suggestions when printed and circulated as the by-laws of a country district. It seems almost incredible that the Local Government Board should sanction the adoption of some of these by-laws by country communities.

The exigencies of space in London have led to the construction of underground offices, with the result that at least a tenth of the inhabitants of modern London are cave-dwellers; and in the by-laws from which I have quoted I find no attempt to penalise, or in any way to restrict, the perpetration of similar barbarities in the country.

If there be underground 'offices,' the drains of the house will leave it at a level of some 10 feet below the ground level, and the public sewer must be at least 11 feet underground, and the laying of sewers at such a depth is relatively expensive. As there are extra charges for high-level water service, ought there not to be similar extra charges for low-level drain service?

The great blot on modern sanitary legislation is the

entire absence of any encouragement for the sanitary well-doers.

Sanitary legislation is founded on a basis of mischievous lop-sided socialism, in which the sanitary well-doer is heavily taxed for the support of the jerry-builder, and is called upon to pay for all the shortcomings of the negligent and filthy.

Encouragement ought to be given to the man who builds a house with ample curtilage; and if such house be removed from all other dwellings by a distance equal to its height, he ought to be freed from the restrictions of harassing by-laws, and the despotic control of district surveyors whose credentials are often of the flimsiest, and whose ideas are stereotyped.

The idea which was prevalent a few years ago, that open spaces should be taxed at 'site value,' is, one must hope, dead. Its obviously mischievous tendency needs no comment.

The only equitable basis for calculating the rateable value of a house for sanitary purposes is the cubic capacity, because, as a broad rule, the bigger the house the greater the amount of work which it throws upon streets and sewers. The 'grounds' or 'curtilage' of a house ought to be very leniently taxed, although one must admit that streets and pavements ought to be paid for in proportion to house and ground frontage.

If a man spend money in beautifying his house without enlarging it, this ought not to entail an increase in rateable value for sanitary purposes. Such beautifyings are good for trade in a proper sense, and ought not in the interests of the community to be checked.

I have been at some pains to point out that in country or semi-rural districts, where it is possible to give a house a decent curtilage or small garden, it is easy

for a householder to make the sanitation of his dwelling quite independent of the local authority. In fact, the householder is able if he be so minded to make his sanitation complete, and to finish, on his own premises and to his own profit, that 'circulation of organic matter' which is a law of nature, and the only true basis upon which the science of sanitation can possibly stand firm.

The householder can do piecemeal what no public authority has ever succeeded in doing wholesale, albeit that millions of money have been wasted in silly attempts.

Why should not the householder be encouraged? One method of encouragement would be to allow him to pay for water by meter, if he be so minded, exactly as he pays for gas. Such a measure as this would effectually solve the water difficulty anywhere.

On referring to p. 69 it will be seen that in 1873 I paid 6*l*. 8*s*. per annum for water. As there were no fixed baths, and washing was not done at home, I reckon the water consumption was not more than seventeen gallons per head per diem.

In 1873 my household averaged nine persons, so that the yearly consumption of water was not more than $9 \times 17 \times 365 = 55,845$ gallons (say 56,000), which, at 6*l*. 8*s*., means about 2*s*. 3*d*. per 1,000 gallons.

In 1896 I reckon that my household averaged four and a half persons, and that the yearly consumption of water was 28,000 gallons, which, at 7*l*. 10*s*. 6*d*., means very nearly 5*s*. 6*d*. per 1,000. Suppose that this house stood in the country, and that it were possible to adopt dry methods of sanitation, this would reduce the water consumption by about one-third, say to 12 gallons per head, 19,000 gallons a year for the house-

hold of 1896. At a shilling per 1,000 gallons, which I believe is a fair price, the water bill would fall to 19*s*.

At a shilling per 1,000 gallons, twelve gallons per diem, or 4,380 gallons per year, would cost 4*s*. 4*d*. per head, or a penny per head per week. If in a country place the rain-water were stored the annual cost for water would be still less.

It may be well to add that twelve gallons per diem allows for a daily sponge bath, and that on this quantity of water absolute domestic and personal cleanliness can be maintained. An excess of water is a pure luxury, and it should be remembered that sewage difficulties are largely proportionate to the amount of water which has to be dealt with.

The supply of water by meter would effectually check waste, which no by-laws and regulations can effect; and if the water mains were frozen, the water companies, very properly, would be the chief losers, and the householder would not be called upon to pay for that which he had never been supplied with.

In the matter of water 'enough is as good as a feast,' and it is idle to imagine that the public health will be improved by a reckless extravagance in this or any other direction.

Finally, is it not possible to consider the sanitary well-doer in the matter of sewerage rates? As it is, the householder who perfects and completes the sanitation of his house on his own premises, very possibly pays more than he who throws the whole of the trouble and expense on the public authority.

He who takes trouble in this matter is regarded as a fool by the majority, who say, 'He has got to pay rates; why should he bother?'

That the burden of public authorities and the pollu-

tion of rivers would be very much lessened by the recognition of the well-doer, there can be no doubt.

In considering the rating of a house for sewerage works it is clear that every sink, w.c., bath, or gully discharging its contents into a public sewer ought to be charged, and such charge should be progressive; thus, if 5*s.* were paid for one such discharge hole, 7*s.* 6*d.* should be paid for the second, 10*s.* for the third, 12*s.* 6*d.* for the fourth, and so on. In this way a cottage with one kitchen sink only would pay 5*s.*, but a mansion with, say, 10 sinks, baths, and w.c. would pay 8*l.* 2*s.* 6*d.* Such charges are analogous to the charges made by water companies, which are higher for the better class of house. If this or something like this were done, the fixed charges on the house would produce a considerable sum, which would go far towards paying the municipal bills for scavenging and sewering. The balance would have to be raised by a rate on the buildings themselves, which rate should be in proportion to the cubic contents of the buildings, without reference to their curtilage, because large curtilage tends to improve the public health more than all the clauses of all the Sanitary Acts that ever were devised.

The cubic contents should alone be considered in making assessments for rates. If a man spend money in making his house more wholesome without increasing its size, and thereby increases its value, it is clearly not in the interests of the public health that he should be fined by the sanitary authority for so doing. Nevertheless this is done daily.

That a man should pay for so much water as he uses and for no more, and that he should pay the municipality for personal services directly in proportion to those services, seem to be two propositions so simple and so

equitable, and so absolutely fundamental for all just dealing, that one cannot be surprised at the trouble which follows the neglect of them.

Great as are the sanitary evils connected with overcrowding, it is probable that the moral and social harm which results from it is infinitely more important; and yet we find that our modern socialistic legislation does everything to encourage and nothing to discourage this greatest of sanitary and social ills.

It is strange that the cubic contents of a building should be a factor which is rigorously excluded from consideration when rating and building regulations are being considered. It seems to the writer to be obvious that it is by far the most important factor, and one which cannot be neglected if our municipal regulations are to have any permanence. The Metropolitan Building Act, we have seen, puts a premium on large buildings, by abolishing all restrictions as to curtilage, provided the building runs from street to street or from street to 'open space,' and never considers the enormous dangers of these large buildings in relation to epidemic disease and fire.

Every country place would do well to enact that—

(1) The height of a house shall in no case be greater than the width of the street upon which it abuts.

(2) Every house shall have a minimum private curtilage upon the ground level, and entirely free from buildings which shall equal the cubic contents of the house divided by 50.

In the second paragraph I have chosen 50 for my divisor, because the average width of a street and the average height of the four-storeyed house are not far from 50 feet.

Let us take the case of an ordinary four-storied

house (with no basement) having an area of 20×50 and 50 feet high. Then the curtilage would be $\frac{20 \times 50 \times 50}{50}$ $=1,000$; *i.e.* the house must have a curtilage exactly equal to the area occupied by the building—a back yard probably, 50 feet deep and 20 feet wide. If in addition to the four storeys there be a basement of 12,500 cubic feet, then an additional 250 square feet of curtilage would be required, and the builder who is tempted to overcrowd would be constantly checked by the price he has to pay for his obligatory curtilage.

The high price of building land is largely due to there being practically no restriction as to the cubic contents permissible on a certain area.

If we take the smaller two-storeyed cottages, having a width of 15 feet, a depth of 25, and a height of 20 feet, then the curtilage would be $\frac{15 \times 25 \times 20}{50} = 150$, which is the minimum of the 'model' by-laws. If the builder put a basement to this cottage of 3,750 cubic feet, he would have to provide additional 75 square feet of curtilage, and thus a check would be put upon underground dwellings and high buildings which obstruct the light and air. On the other hand, there need be no restrictions on the height or cubic contents of any building provided its curtilage be ample.

If it were possible for the first house considered to have a height of 100 feet in addition to its basement, then, the cubic contents being 112,500 feet, the curtilage would have to be 2,250 square feet, and the house and curtilage combined would occupy some 3,250 square feet, or rather less than $\frac{1}{13}$ of an acre.

It is probable that a comprehensive rule of this kind would satisfactorily keep builder and site speculator in

order, while it placed a minimum of restriction on the originality and fancy of architect and builder.

Builders of houses wholly detached from other houses or boundaries by a distance equal to the height of the house should be allowed to escape altogether from the harassing 'model' by-laws and the tyranny of the surveyor.

I would say finally—

1. That overcrowding is the greatest of all sanitary evils, and far and away the greatest of all moral evils.

2. That whatever increases the cost of the dwelling inevitably increases overcrowding.

3. That overcrowding is facilitated by modern methods of sanitation.

4. That, unless the crowding of houses be prevented, great schemes of sewerage and water-supply will eventually make the health of a district worse intead of better.

5. That 'open spaces' and public gardens do not compensate for the lack of light and air in the dwelling or of curtilage around it.

What one may call municipal luxuries are not permissible if they permanently increase the cost of the dwelling.

If such luxuries be self-supporting they may be permissible, but it is clear to my mind that, as a rule, they should be left to be provided by private munificence or voluntary public subscription. They ought never to be paid for out of the rates.

The avowed policy of many municipalities is to practise a maximum of extravagance, in the belief that such extravagance benefits the poor, and these vicarious philanthropists receive a willing support from those who are directly interested in such schemes.

6. That if great schemes for sewerage, or water-supply,

or the provision of open spaces, be effected by loans which increase the rates for long terms, and thereby permanently increase the cost of the dwelling, they will inevitably lead to a deterioration in the public health and morals. Some of these schemes *facilitate* overcrowding, while *increased rates*, by raising the cost of the dwelling, *compel* it.

7. Municipal ostentation is wholly indefensible. To build palatial offices costing a million and more of money, and thereby saddle the ratepayers with another loan, is indefensible. To buy a cocked hat for the mayor out of the rates (as did a less ambitious municipality) is equally indefensible, and serves no useful purpose except to raise a laugh.

We have been long accustomed to hear that our chief sanitary necessity in this world is pure water. This would be quite true if we were fish. But it is obvious that the purity of the air we breathe is of far greater importance than the purity of the water we drink, seeing that we must take a draught of air about twenty times a minute, while many of us do not take a draught of raw water from week's end to week's end.

If the huge death-rate of the Strand were due to impure water, we may be sure that there would be no lack of discussion thereupon; but as it is due to overcrowding, and the filthiness of the air consequent upon overcrowding, we hear nothing about it. To make any serious attempt to check overcrowding would interfere with trade, and therefore it is considered silly and futile to discuss such a matter. Any man who supposes that considerations of hygiene will be allowed to interfere with trade, is, I think, deceived. At all events, I have no such belief.

My sole object in discussing these matters is to warn country places against blindly following the lead of London in sanitary matters.

The citizens of London have seldom had an eye to anything except immediate profit. They allowed Moorfields and the Drapers' garden to be sold for enormous sums, without a thought for the health of the thousands of young men and women who daily toil in that overcrowded spot called 'the City;' and they have taken no heed of the Registrar-General's returns, which are telling them that the death-rate of males at the prime of life (*i.e.* between the ages of thirty-five and sixty-five), which has been steadily rising for the whole kingdom, is nearly 70 per cent. higher in London than it is in the best country districts.

A crying need in London is for back doors and back streets between the houses for delivering goods, and beneath which could be laid the various subterranean pipes and wires, the repairing of which is so frequent a cause of blocking the main thoroughfares. A system of back streets would do more to facilitate the traffic of the thoroughfares than a similar addition made to the width of the main streets.

Many attempts have been made from the days of Elizabeth downwards to restrict the growth of London, but all such attempts have proved unavailing. The most determined of these attempts was in 1657, under the Commonwealth, when an Act was passed which inflicted a fine of one year's rent upon all builders and occupiers of houses which had been erected within ten miles of the City Wall since the 25th day of March, 1620, and further directed a fine of 100*l.* to be levied on all persons who should erect 'any dwelling-house, outhouse, or cottage within the limits mentioned without assigning four acres of ground to every such dwelling-house, &c., respectively.' In 1757, when what was called the New Road from Paddington to Islington was

made, the Building Act provided that no house should be erected within fifty feet of the road, showing that in the days of George II. our legislators had some sense of the necessity for checking overcrowding of houses.

Again, we should be careful how we abandon any customs which serve to mitigate the evils of overcrowding. We are now engaged in burning all organic refuse, and some of us are urging the cremation of the dead. The proper destination of all organic refuse, including the dead body, is burial, and the necessity of providing land for cemeteries, and for the productive utilisation of organic refuse, is a great and undoubted boon to the living, by serving to perpetuate open spaces in the neighbourhood of towns. Destructors and crematoria may be necessary, but it is impossible to regard the burning of organic refuse as a scientific method of disposal, and most certainly it must add impurities to our already too foul atmosphere. Effete organic matter of all kinds, if rationally treated (*i.e.* superficially buried), will freshen the air and yield an increase for the living. When we wantonly burn such valuable matter we ought to feel a twinge of conscience, as we hope the servant-girl does when she lights the kitchen fire with slices of bacon.

It is an astonishing thing that no London parish has had the enterprise to arrange for the systematic carriage of its organic refuse into the country by trains, and the establishment of a farm colony for its unemployed.

Market-Gardens

Almost the only branch of British agriculture which is still in a fairly prosperous condition is market-gardening, and few who have not lived in the suburbs of London can form any idea of the vast importance of

this industry from the economic and sanitary points of view.

William Cobbett, in his 'English Gardener,' says (speaking of the London market-gardeners): 'These gardeners excel all the world in everything that they undertake to cultivate; they beat all the gentlemen's gardeners in the kingdom; nothing ever fails that depends upon their skill; and I should be ungrateful indeed if I did not acknowledge that I have learned more from them than from all the books I have read in my life, and from all that I ever saw practised in gentlemen's gardens.'

This eulogium still holds good; and, indeed, the quantity of food that is raised on the market-gardens round London is simply astounding.

The comparative prosperity of the London market-gardeners is due to two facts: the proximity of an insatiable market, and the possibility of getting an almost unlimited amount of dung from the London stables. This dung is very cheap, because the Londoner is obliged to get rid of it at any price, and in many instances he even pays in order to have it removed.

The quantity of dung which is put upon the London market-gardens is prodigious, and although the amount varies with the crop to be raised, the average is stated, on the authority of two well-known gardeners, to range between sixty and eighty tons per annum to the acre. The amount used for raising onions is very large, and it is larger still on the grounds devoted to growing gherkins and ridge-cucumbers. I am given to understand that it is possible to put as much as 200 tons of stable manure on an acre of ground, although it would be difficult to get any return from land which is of such a hungry nature as to take such a large

quantity. These figures are of interest as showing how enormous is the power of cultivated land to appropriate organic manure, and how groundless are any fears as to the land becoming foul provided it be laboriously tilled.

The rent paid for market-garden ground very commonly amounts to ten pounds per acre, and if the ground be planted with orchard trees, as much as fourteen pounds per annum may be obtained.

The capital involved in market-gardening is very great, and the plant required—store-houses, tools, carts, horses, baskets, glass-houses and lights—is far more complex and costly than that required for farming.

The labour necessary for market-gardening is very large indeed, and many of the gardeners in the district which I have in my mind pay as much as 300*l*. a week for wages in the summer, and about half that amount during the slack season.

The traffic on the main roads which lead from the gardening districts to London is astonishingly great, and the stream of carts wending towards market with their loads of produce, or returning from market with their loads of dung, never ceases during the whole of the twenty-four hours. When one considers the high rent, the large sums paid for wages, and the enormous amount of manure used (which, I believe, costs about half a crown per ton delivered on the land), it is evident that the yield must be infinitely greater than that obtained by the farmer; were it otherwise, no profit could be made. No better instance than this could be given of the magnificent results obtained by the scientific use of organic refuse.

The London stables are, as a rule, the perfection of cleanliness, because the dung, which is capable of being

turned to very profitable use, is eagerly sought after and removed. The London market-gardens are the most productive in the world, because the stables are clean. This is hygiene worthy of imitation.

When in spring the train runs through these gardens, all ablaze with blossom and redolent of wallflower, with rows of men and women busy planting, or hoeing, or weeding, or gathering, and ultimately as it enters London pulls up opposite a gaunt enclosure with a furnace in the middle and a despairing notice on a big spoil heap that clinkers will be *given* away, it is impossible not to make comparison between the *right* as opposed to the *wrong* use of refuse. And if Trafalgar Square should happen to be filled with unemployed, one is still further driven to the reflection that possibly such gatherings are but an illustration of the old proverb that 'wilful waste makes woeful want,' and that one of the legitimate occupations of these unemployed should be to turn the organic refuse of the city to productive purposes, and so extract work and food and wages from their only source, the earth, and in so doing maintain open spaces near cities, to regenerate the freshness of the air and keep the inhabitants to some extent apart.

It will be urged that these views are impracticable, because overcrowding is necessary for business, and it is indeed asserted by some that the commercial prosperity of this country and of America is largely due to the fact that the business men are content to literally crawl over each other in an ecstasy of frenzied competition which is making existence a burden. It is certain, however, that this question of overcrowding on space is one which must be dealt with in the future in no niggardly spirit, and that our national and commercial prosperity very largely depend on our willingness and ability to face it. The

inadequate housing of the working classes has probably more to do with their chronic discontent than is generally supposed. A real 'home,' be it remembered, is a very different thing from a room in a barrack. A home that is clean and bright and beautiful, the beauties of which have increased year by year under the owner's fostering care, where the children have space to grow up healthily, and where there is some escape from the dirt and din of the workshop—a home in which it is possible to take a pride, and which is a source of daily pleasure—is something which a man will weigh carefully in the balance before he lightly determines on throwing up his employment. A decent home without sufficient space is impossible, and the sooner great industrial companies and employers of labour grasp this idea the better. That the labouring classes are beginning to grasp it is shown by a recent agitation in the East End of London against replacing the two-storeyed houses by industrial barracks. The fashion of piling people in heaps, and offering them libraries and bagatelle-tables as a compensation, must come to an end, and one looks forward hopefully to the working of the Allotment Act, especially when it is recognised that the proper place for the allotment is round the house. Thirty perches (rather less than a fifth of an acre) is the maximum amount of garden which a man can cultivate in his leisure time, and it is the little bit of garden which converts a dwelling into a home, which provides a delightful occupation for a man's leisure hours, which freshens the air round his dwelling, which keeps him from the tavern and the sixpenny betting hell, and which is capable of turning all the refuse of the house into profitable garden produce. Not much improvement is to be looked for until the conscience of the educated and upper classes has been

roused. As long as persons in high position are content to leave their broad acres and swelter for the season in highly decorated 'bijou residences,' where the servants are poked away underground or in miserable attics, not much improvement can be expected. Many of the persons who come to London for the season are philanthropists whose hearts 'bleed' for the miseries of the East End. These people forget that when they come to town they make it necessary for humbler people who minister to their wants to come to London also; and that, if they who are wealthy are content to live on a very insufficient area, their poor dependents must necessarily be packed together in great discomfort and at the cost of their physical and moral well-being. Let those who are sorry for the state of overcrowding in cities stop out of them, and spend their incomes in the country. If they can succeed in making those who live round them in the country happy and contented, and thus check the rush for the towns, they will do infinitely more good than by subscribing to city missions or 'People's Palaces.' Unless we can succeed in checking the overcrowding of cities by some such regulation as that which has been suggested, it is probable that all the money we have spent and are spending on so called sanitary improvements is money thrown away, and that, in so far as modern hygienic methods have enabled people to live closer packed than heretofore, they have worked mischief rather than good. Those who have the control of developing districts will do well to keep them as rural as possible, and to encourage private gardens by every means in their power. The house ought to be taxed in proportion to its size, and not the garden round it; for a garden is a great boon in a town, even to those who do not own it, because it serves to keep the dwelling-

houses asunder. A person who owns a garden may, if he be so minded, be quite independent of the sanitary authority; and a wise sanitary authority will do well, by a remission of taxation, to encourage him by every means in its power. So long as sanitary authorities are content merely to encourage the jerry builder by clearing up his messes and making good his deficiencies, not much improvement is to be expected. Such policy may be 'good for trade,' but it is not good for the public health.

Finally, one hopes that it may be increasingly possible for a man to own his dwelling and the ground around it, and that the transfer of land may be much facilitated. Without wishing to embark on a discussion as to the relative advantages of large and small holdings, it seems necessary to point out that no one is so likely to do justice to the land and to improve it as the absolute owner, whether he owns a thousand acres or only one. If a man owns a bit of land, be it farm or garden, he is bound in self-defence to make the best of it, and he can have no object in quarrelling with, cheating, or shooting his landlord. This last is a point which political economists not unfrequently neglect. We are often told that large holdings are more economical than small ones, and it is pointed out that on the farms of our large proprietors the yield per acre is greater than the yield on the land of the peasant proprietors of France or elsewhere. Our big farmers, however, have not of late years grown rich, and it is doubtful if free trade is the sole cause of this. Is it not possible to farm too high for profit? We may drive a steamship ten knots an hour at a profit, but lose by attempting to get fifteen knots out of her. So I fancy that much of the profit of farming is frittered away in a lavish expenditure on artificial fertilisers, in the desire

to get excessive crops. Small holdings and gardens and what has been called the dovetailing of the houses and the land, have two advantages which are often lost sight of. The first is, that the producer and consumer are largely identical, so that the middleman and free trade are alike powerless to do him harm. The second is, that all the refuse of the house is available for the land, and in proportion to its amount is the expense of buying 'artificials' and the risk of keeping stock done away with. The key to good agriculture is thrift, and no arrangement more thrifty than that which has been indicated can be conceived. The key to good sanitation is agriculture, and therefore no effort should be spared to maintain a rural element even in our great industrial centres.

Building Societies

The facilities for overcrowding which are afforded by big schemes of water-supply and sewerage are now well understood, and have caused the formation of 'Building Societies' throughout the country. A large number of these societies during the past few years have been proved to have been dishonestly managed, and have involved wide-spread financial disaster amongst the poor and thrifty.

The mode of proceeding of these societies is to buy up, on the outskirts of towns having a system of sewers and a common water-supply, plots of land abutting on roads which have been sewered at the expense of the ratepayers.

These plots are then sold to purchasers who pay 10 per cent. deposit for possession, and pay the rest of the purchase money in monthly or quarterly instalments for a term of years, 10 or 15, as the case may be, with 5 per

cent. interest. Thus the artisan, having paid a mo exorbitant price for a plot of ground, starts in life with mortgage round his neck, and probably finds, should an thing interfere with the regular payment of instalment that he has a hard-faced usurer to deal with who merel

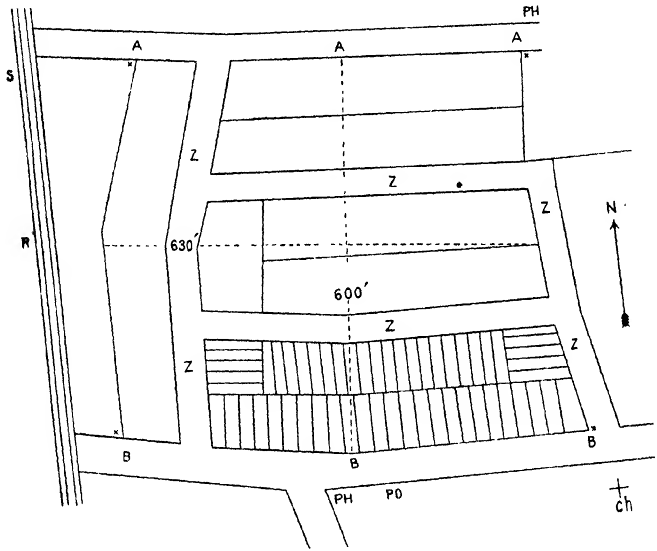


Fig. 5

concealed his identity behind the title of 'Company, Limited.'

The accompanying diagram (fig. 5) gives a good idea of the development of a district subsequent to sewering. It has been copied from the prospectus of a Building Society. A A A is an old road having houses on the north

side only; B B B is an old road with houses on the south side only, *i.e.* seven dwelling-houses in a course of more than half a mile.

The space between A A A and B B B was, until a few months before the issuing of the prospectus, a market-garden full of fruit trees, and about nine acres in extent.

A few years ago A A A and B B B were sewered at the expense of the ratepayers, and very soon afterwards this market-garden was bought by a 'Building Society' and converted into a 'building estate.'

It is obviously a very 'eligible' estate, for there is a Railway (R.), with a Station (S.), a Post and Telegraph Office (P.O.), a Church (Ch.), and two Public Houses (P.H.). None of the elements of modern civilisation are wanting. After the sewering of roads A A A and B B B, the District Council, in a fit of zealous extravagance, destroyed the gravel paths at the side of B, and put a 12 by 6 inch kerb, and laid half a mile of granolithic pavement for the benefit of the aforesaid seven houses.

When the Building Society issued the prospectus the plots abutting on the old roads A A A and B B B were sold at once, and the reason is obvious, viz. that the roads are ready made and sewered; and a note with regard to road B B B says, 'This road is a highway maintainable by the local authorities, who will provide a proper footway in front of the plots in due course.' The ratepayers as a whole are to provide pavements for the speculative builder in this particular instance, and it is evident that the owners of the plot and the Local Council had come to an agreement in the matter. The houses abutting on the new roads, Z Z Z, will, in addition to the purchase money for the land, be charged 8*s*. per

foot frontage for sewers, and 'also such a proportion as their surveyor shall assess of the expense of repairing and maintaining the road or roads, until the same shall be handed over to the local authorities.' On an adjoining property the cost of 'making up' a private road was estimated at 12*s*. per foot run, so that the cost would amount to between 10*l*. and 11*l*. for a plot having a frontage of 18 feet, and might form a ruinous charge on some of the corner plots.

The ground will accommodate 177 plots, and the plots facing the old roads fetched 3*l*. a foot. Of these there is room for fifty-nine, having a frontage of 20 feet each, so that the price paid for these at 60*l*. per plot would be over 3,500*l*.; and if the remaining 118 plots fetched 40*l*. each (4,720*l*.), the total price realised for this 9 acres would be over 8,000*l*., in addition to the charge for sewerage and road-making.

When, moreover, it is remembered that the society may possibly hold a mortgage on every plot and every house, for which they get 5 per cent. and excellent security, it will be admitted that running a 'Building Society' is a tolerably profitable business.

If all these plots are sold there will be a population of over 1,200 persons on 9 acres of ground, and the ratepayers will be at the charge not only of educating the children, but of providing hospitals for the segregation of infectious diseases, allotments, free libraries, open spaces, and additions to the sewerage works for dealing with the sewage of 1,200 persons.

When a 'progressive' municipality sets to work to 'develop' its district (a speculative and hazardous process, which it should leave to private enterprise), the ratepayer soon begins to see that a great diversity of interests has to be served.

The shopkeeper (and it is of this class that Boards and Councils are largely composed) wants the greatest number of people on the smallest space; and he sees that in proportion as the dwelling has an insufficient curtilage, so are its inhabitants wholly and entirely dependent on the shop.

The person with a fixed income who settles in a district wishes the district to remain picturesque, rural, and quiet, and, above all, he desires that the 'rates' may be kept down. He naturally objects to be taxed for the sewering of country roads in order that the fields may be covered with courts and alleys of jerry-built houses, and equally he objects to be taxed in order that every railway station in the country may display a large invitation to trippers to invade his solitude and make his life a burden.

CHAPTER III

THE SHORTCOMINGS OF MODERN SANITATION

The chief aim of sanitarians has ever been, and ever will be, the securing for the masses of the people the necessities of life—pure air to breathe, pure water to drink, pure food to eat. Whether or not we are able to secure these necessities depends very largely upon the method which we adopt for the treatment of putrescible refuse; and it is to this point, and the modern fashion of mixing putrescible refuse with water, that the present chapter will be devoted.

It may be well to remind the reader that all dead organic matter is putrescible, and that, when putrescible matter is spoken of, all organic matter, inclusive of excrement, is meant.

Nature moves in a circle, animals feed on each other and on vegetables, vegetables feed on the dead bodies of animals and vegetables, and on the solid and gaseous excrements of animals. Animal and vegetable life are complementary, and mutually support each other. This is a law of nature, and in making this assertion I run no risk whatever of being contradicted.

The laws of nature are inexorable; *i.e.* they are not to be set aside by human prayers—not even by that best of all prayers, labour. Those who disobey the laws of nature, or who enter into a contest with her, are sure to

be worsted in the end. If we fight with nature we court calamity.

Those who fight with nature may be compared to Sisyphus, who, according to the old mythology, was condemned in the lower world to a never-ending contest with the force of gravity—

> With many a weary sigh and many a groan
> Up the high hill he heaves a huge round stone;
> The huge round stone, resulting with a bound,
> Thunders impetuous down, and smokes along the ground.

By means of great expenditure of time and money, we may wage for a period with nature a war which may be apparently successful. The war can never be really successful, it will never terminate; nature in the end will assert her eternal sway, and crushing defeat must be our lot.

As the inevitable destiny of putrescible matter is to become the food of vegetables, a destiny which we can delay at the most only for a brief period, our proper course in dealing with it is clearly not to attempt to prevent or even to delay the inevitable. Such a course is to disobey the laws of nature, to fight with her and court ultimate defeat. Our wiser plan is to help nature in her work, and thus win her smiles.

It has been the wise custom in all ages of the world to dispose of putrescible matter by burial in the earth. Dead bodies have in all ages been buried, and the greatest of all lawgivers and sanitarians, Moses, gave most explicit directions that excremental matters should be treated in the same way.

This is a not unimportant fact, and although we do not in this country follow the whole of the Mosaic law, nevertheless, that law is so pregnant with marvellous wisdom, that we ought not to discard any item of it

without first questioning ourselves most strictly as to our reasonableness in so doing. The latest advances of modern science seem to show that in this particular Moses was absolutely in the right.

It has been shown, I think conclusively, that the decomposition of organic matter, whether in the earth, air, or water, is brought about by minute fungoid organisms, the growth of which has the effect of resolving the highly complex organic compounds into soluble salts or gaseous bodies, which can be absorbed by the roots of plants.

Now when putrescible matter is buried in the earth it undergoes decomposition without the occurrence of putrefaction—that process which is at once offensive to the senses and dangerous to health. This is effected by means of fungi, which produce oxidation of the organic bodies. If sufficient air has access to the pores of the soil, and if sufficient moisture be present, the nitrogen takes oxygen to form nitric acid, and thus, combining with the bases, forms soluble nitrates. The carbon also in a similar way forms carbonic acid and carbonates.

A good account of these active organisms which are ever present in the soil will be found in a paper by Professor Wollny,[1] of Munich. These organisms are so incalculably numerous that their activity must be exceedingly widespread. Koch found enormous quantities, even in winter, in the soil not only of crowded places like Berlin, but in that also of remote fields. At the observatory of Montsouris 750,000 were found in a gram of earth, and at Genevilliers from 850,000 to 900,000. Warington estimated that a gram of dung from a cow fed on hay contained 165,000,000 microbes.

[1] 'Ueber die Thätigkeit niederer Organismen im Boden,' *Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege*, vol. xv. p. 705, 1883.

If the action of the microbes be checked by antiseptics, the vapour of chloroform or heat (100° C.), the chemical changes in the earth cease.

That the formation of nitrates and carbonic acid from organic matter in earth to which earth has access is due to microbes has been proved by direct experiment. When, however, organic matter is mixed with earth, and air is admitted in insufficient quantity or entirely excluded, the decomposition is of another kind; and besides small quantities of carbonic acid and carburetted hydrogen, there is formed water, ammonia, free nitrogen, and a great quantity of a black carbonaceous peat-like matter (the so-called sour humus).

Schlösing found that the nitric acid in the soil disappeared when the air was replaced by nitrogen.

The kind of organism seems to vary with circumstances. As long as air is freely admitted, the mould-fungi (*Schimmelpilze*) preponderate; and when air is excluded, the schizomycetes (*Spaltpilze*) increase.

The formation of nitric acid in organic earth mixtures depends on the amount of oxygen which is present in the air admitted.

Miller and Boussingault have shown that no nitrification takes place in thoroughly soaked earth to which little air has access, and that when oxygen is absent the nitrates in the earth are reduced. The formation of carbonic acid also depends upon the admission of air (containing free oxygen), but some carbonic acid is formed even though all air be excluded.

Nitrification is assisted by a moderate amount of moisture. It attains its maximum when the moisture reaches 33 per cent., and above and below this the process of nitrification and formation of carbonic acid is hindered.

Temperature has a great influence on oxidation in the earth. Oxidation reaches a maximum with a temperature of about 50° C. (120° F.), and stops at 55° C.

Oxidation goes on most quickly in the dark.

Thus, oxidation depends not only on the presence of the organisms, but also on the presence of other factors, such as suitable aeration, suitable moisture, suitable temperature.

These factors may all be suitable, or some may suit and others may not suit the oxidation process.

The decomposition of organic matter in the soil is governed by that factor which is at its maximum.

The process of decomposition is much influenced by the physical condition of the soil, as, *e.g.*—

(*a*) Permeability for air and water.

(*b*) Nature and permeability of subsoil.

(*c*) Slope.

(*d*) Aspect.

(*e*) Warmth dependent on aspect, mineral composition, colour and moisture and nature of the crop. Barren soils are warm, while those covered with green crops are cool.

All changes which organic matter undergoes in the earth are thus seen to be brought about, almost exclusively, by the life of organisms, the activity of which obeys the same natural laws which govern the growth of higher plants. There can be no better illustration of the true economy of nature than this action of the microbes in the soil on the conversion of organic matter into soluble salts and gases which serve as food for plants.

The growth of the microbes depends upon the concurrence of those conditions which, by experience, we all know to be favourable to the growth of higher plants.

There must be a good supply of free oxygen, sufficient, but not too much moisture, and a summer temperature. In well-tilled ground, broken up so as to admit air to its pores, and in a 'fine growing season,' in which sunshine alternates with showers, this process of oxidation is at its maximum. The microbes are active beneath the surface manufacturing plant food from organic matter, and the favourable conditions above soil and below cause a vigorous growth of crops.

When, on the other hand, the weather is unfavourable, and when, in consequence of excessive cold, excessive drought, or excessive wet, crops are not developed as they should be, the microbial life is also checked, and the change of the organic matter is delayed, and it is stored up for future use in more favourable seasons. This is an explanation apparently of the fact well known to farmers, that the effect of organic manures is more permanent than that of the so-called artificial manures, which at present are so much in vogue. The organic manure remains entangled in the soil, and is not readily washed out of it in winter when the temperature is low, or even in unpropitious summers. It cannot be washed out until microbial growth has changed it into soluble salts, and when this change takes place, which it does in 'good' weather, the roots of the growing plants seize hold of the ever-forming soluble salts and appropriate them to their own use. In fact, the farmer who uses organic manures from the farmyard or elsewhere need trouble himself very little with agricultural chemistry or experiment.

He may feel certain that if he buries his organic manure *directly it is produced* it will not be wasted. It will not give off ammonia to the air, nor will the juices be washed away by rain to the same extent as when it is

left above ground to be a nuisance. There seems to be no doubt whatever that all heaps of manurial matter which give off ammonia and other gases to poison the air, and perhaps do more serious mischief, are allowing valuable matter to escape, which ought to be undergoing oxidation in the earth. There can be no doubt whatever that to the agriculturist stink means waste, and it is to be hoped that, when the bucolic mind has imbibed this great and important truth, the country will be more evenly pleasant than it is.

The reasons why farmers allow putrescible matter to fester in heaps appear to be—

(1) That the matter has to wait until land is clear and circumstances permit of its being dragged to the fields; and (2) that when the matter is thoroughly rotten and most offensive, a *more rapid and visible* result is produced, notwithstanding that the total result is probably less than if it had been applied to the ground at once. It is certain that putrescible matter intended for manure must waste more above ground than when buried immediately beneath it. Rich farmers are now building sheds over their yards to prevent the access of rain to the manure, and are providing tanks for the reception of liquid which drains away. This involves a very great expense, and it is at least doubtful whether the result is better than that got by the immediate application of such matters to the soil—a process which involves no extra expenditure of any kind—a most important matter, because the only acceptable test of good husbandry is the balance-sheet.

Mr. Warington, F.R.S., in his valuable little book on 'The Chemistry of the Farm,' says: 'The most complete return to the land would be accomplished by manuring it with the excrements of the men and animals consum-

ing the crops' (p. 28); and again, 'Farmyard manure is a "general" manure; that is, it supplies all the essential elements of plant food. . . . The effect of farmyard manure is spread over a considerable number of years, its nitrogen being chiefly present not as ammonia, but in the form of carbonaceous compounds, which decompose but slowly in the soil.'

The immediate return is often less than when artificial manure, consisting of soluble nitrates and phosphates, is used, but the important point seems to be that the return is tolerably sure to come in the long run.

While it is impossible to overestimate the debt which agriculture owes to chemistry, we have, nevertheless, learnt from the bacteriologist that there are biological problems underlying the question of fertility, and that a mere chemical estimation of the constituents of organic manure is insufficient, by itself, to fix its manurial value. It is by the agency of bacteria that organic matter is changed into nitrates and other soluble salts, which are absorbed by the roots of plants and serve to nourish them. This change only takes place provided the temperature and moisture are suitable and the ground be properly tilled. Drought and frost arrest the change, and excess of moisture, by closing the pores of the soil, does the same thing.

Organic manures are economical in the long run, because if the weather is adverse they bide their time until the advent of 'fine growing weather.' If one season prove unfavourable, a large amount of the organic matter remains in the soil to nourish the next crop. This is not the case when soluble chemical manures are used.

That it is necessary to put dung upon the ground if

we are to maintain the fertility of the soil has been the experience of all peoples in every age.

This is shown by a diagram (fig. 6) which represents by a curve the yearly produce of barley, in bushels per acre, grown continuously on the same plots of ground for forty years, but with this difference, that one plot (represented by the upper curve) received 14 tons per annum per acre of farmyard manure, while the other, represented by the lower curve, has been unmanured continuously. This diagram has been constructed from figures given by Sir John Lawes and Sir Henry Gilbert in the 'Transactions of the Highland and Agricultural Society of Scotland' for 1895. I have replaced fractions by the nearest whole figure. The fluctuations of both these curves are very great, and it will be noticed that they are exactly parallel to each other. This teaches us that weather is the most important factor in agricultural success, and shows the extreme danger to the farmer of 'placing all his eggs in one basket,' as has been done by the so-called farmers of the Far West, who have attempted to grow wheat *only* by the process of scratching the prairie, without returning any dung to the soil, and many of whom have been financially swamped by the first bad season.

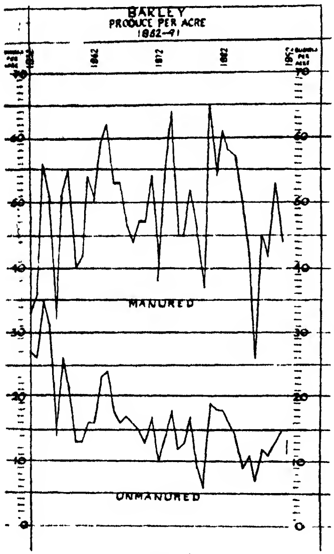


FIG. 6.

Taking the average of the forty years, it will be found that the produce of the manured land averaged 49 bushels per acre per annum, while the unmanured land gave only 16½ bushels.

I might have added to the diagram a third curve showing the produce of that plot of ground which, of all those manured with artificials, gave the highest yield. The yield of this plot for the whole forty years averaged 46 bushels, or only 3 bushels short of the average yield of the plot treated with farmyard manure. If, however, we take the average yield of the three plots for each of the four decades comprising the forty years, the value of the organic matter becomes very manifest. Thus the yield for each decade was with

Farmyard dung . .	44·9	51·5	50·0	51·6
Artificial manure . .	48·7	49·4	42·8	41·5
Unmanured	22·2	17·5	13·7	12·6

It will be observed that the yield from artificial manuring only exceeded the yield from the farmyard plot in the first decade, when it showed an excess of 3·8 bushels. In the other three decades it was deficient by 2·1, 7·2, and 10·1 bushels.

The deficiency of the unmanured plot in each decade, as compared with the farmyard plot, was 22·7, 34·0, 37·3, and 39·0.

These figures are very convincing, and as practical agriculturists seem to be now agreed that farming is hopeless without an adequate amount of live stock to furnish dung, no more need be said upon this head.

In the season of 1890 the results obtained with organic manure were so remarkable that they deserve to be quoted, although they have not the value of the twenty-year averages.

The yield of barley on the plot dressed with farmyard manure was 53 bushels of grain and $29\frac{1}{8}$ cwts. of straw (against $47\frac{1}{2}$ bushels and $22\frac{3}{4}$ cwts. on the best of the artificially manured plots), and the yield of wheat on the plot dressed with farmyard manure was 50 bushels of grain and $48\frac{5}{8}$ cwts. of straw against 48 bushels and $46\frac{1}{4}$ cwts. on the best of the artificially manured plots. The season of 1890 seems to have been characterised by a rather dry spring and a rather wet summer.

In 1893—which was a year of drought, the rainfall for the year being nearly 6 inches short—the wheat crop in all the southern and south-eastern counties of England was very much below the average, *i.e.* about 23 bushels to the acre instead of 30 bushels. The wheat, however, was of high quality, and, according to the Journal of the Royal Agricultural Society, 'in one or two cases weights of 65 lb. or even 67 lb. per bushel were reported.' The average weight of a bushel of wheat is about 60 lb.

At Rothamstead, in 1893, Sir John Lawes reports that his plot dressed with farmyard manure produced $34\frac{1}{4}$ bushels of dressed grain (weighing $63\frac{3}{8}$ lb. per bushel) and $20\frac{1}{8}$ cwts. of straw, while the most productive of his artificially manured plots yielded $21\frac{3}{4}$ bushels (weighing $62\frac{2}{8}$ lb.) and $13\frac{7}{8}$ cwts. of straw. Thus in this exceptional year of drought the farmyard manure produced an average crop of wheat of most exceptional quality, which goes far to prove the truth of the dictum that 'dung means moisture.'

Again in 1898, at Rothamstead, the plot dressed with nitrate of soda yielded 23 bushels, as against 38 bushels on the farmyard plot, and in explanation Sir John Lawes said ('Times,' Oct. 22, 1898), 'For only the second time during a period of more than forty years the wheat plant was much injured where we have used the heaviest

dressing of nitrate of soda for want of enough rain to form and distribute a sufficiently dilute solution of it.'

It is a great mistake to suppose that farming is in any way comparable to a chemical experiment. In experiments conducted in the laboratory the chemist is able to control *all* the conditions of the experiment, but in farming the condition which above all others influences the result, viz. the weather, cannot be controlled.

When chemical manures are used with judgment and applied at the right moment, and when the weather is favourable, there is no doubt that the result is often surprising and gratifying. When, however, the weather is unfavourable, when the drought is so great that the chemicals cannot be dissolved, or when the rain is so heavy that they are washed out of the soil, the result is not encouraging. If organic manures are used, they waste but little in bad seasons, and much remains in the ground for next year's crop. The farmer, however, who applies chemicals in a bad season gets neither crop nor residuum of manure for next year. Mr. Warington says that 'farmers have a prejudice in favour of the latter' (*i.e.* organic) 'manures, but it is clear that the quickest return for capital invested is afforded by the former class' (*i.e.* inorganic).

Surely we have no right to blame the farmers for their prejudice, which seems to be in all respects reasonable. The doctrine has obtained in this country of late years that it is good economy to waste all our home-grown organic manure, and to import chemicals from South America for the purposes of agriculture. This is a strange doctrine; but one may hope that ere long our farmers will begin to clamour for that which we now waste so wickedly.

One more word before bringing these remarks on

farming to a close, remarks for which no apology is needed, because their bearing on the subject of sanitation must be obvious.

It will be noted that in the hands of Lawes and Gilbert farmyard manure gave better results with barley than with wheat. May not the fact that farm animals are largely fed with barley-meal have something to do with this? These are experiments which show that minimal ingredients in manures are not without effects which are often surprising. There are *a priori* grounds for thinking that the best manure for barley must be the excrement of a barley-eating animal, for in that excrement must be all that is necessary for barley. It is to be regretted that some agriculturist does not make the experiment of growing wheat with the excrement of a wheat-eating or bread-eating animal. As a gardener, the author has grown potatoes with the excrement of a potato-eating animal, and certainly the result has been most encouraging.

One has been obliged to draw illustrations as to the practical result of burying organic matter from the agricultural employment of farmyard manure, because facts based upon exact experiments with the organic refuse of our towns are not forthcoming.

In my 'Milroy Lectures,' p. 116 (Longmans, 1902), will be found an account of Carrington Moss, an estate of 1,100 acres, which has been fertilised with some 700,000 tons of fæcal and other organic refuse from the city of Manchester. The broad result has been that land which formerly returned a shilling an acre for sporting rights is now let to responsible tenants for 2*l.* per acre per annum. The finest wheat crops which it has ever been my lot to see I have seen at Carrington. The fertility of this whilom peat-bog is now remarkable.

The great fertility of the soil of Holland is largely due to the fact that all the human excreta are returned to it.

The point to be insisted upon is this: that the proper destiny of organic refuse is immediate burial just below the surface of the soil.

Most of the shortcomings of modern sanitary methods are due to the fact that in our dealing with organic refuse we commit a scientific error—*i.e.* we pursue a course which is in opposition to natural law.

This error consists in mixing organic refuse with water.

When organic refuse is mixed with water it undergoes changes which differ widely from the changes which it undergoes when mixed with earth.

According to Wollny, whose paper has been quoted previously, the process of oxidation of organic matter and the formation of nitrate take place most readily when a moderate amount of moisture is present. The most favourable amount is about 33 per cent., and if the moisture rise above or sink below this amount, the process of nitrification and the formation of carbonic acid are hindered. When water is in excess the amount of free oxygen is insufficient to favour the growth of the necessary fungi, and, instead of oxidation, putrefaction takes place, with the formation of ammonia, free nitrogen, carbonic acid, and carburetted hydrogen. Under these unfavourable circumstances it is possible that the nitrates which may have been formed may be again reduced.

This process of deoxidation takes place in mixtures of putrescible matter with water, and takes place also, it is said, in soil which is thoroughly soaked with sewage (*i.e.* putrescible matter mixed with water). In the face of these facts, it is not to be wondered at that 'sewage

farming,' which is farming under acknowledged difficulties, has not proved a commercial success. We must, indeed, be in doubt whether, when the circumstances are more than usually unfavourable, it exercises any very great purifying action upon the putrescible mixture. In the treatment of putrescible refuse, so that it shall not be a danger or annoyance, what we have to aim at is nitrification rather than putrefaction, and it is certain that by mixing with water putrefaction is encouraged and nitrification delayed.

It will be within the recollection of most readers that in January 1893 a sharp outbreak of cholera (affecting 115 persons, and causing 40 deaths) occurred in a lunatic asylum at Nietleben, on the Saale, a village not far from Halle.

In the *British Medical Journal* for February 4, 1893 (p. 250), is the following note from the correspondent of the *Journal* at Berlin: 'The Nietleben epidemic seems a further proof that contaminated water is the cause of cholera. The water arrangements of the asylum are, on a small scale, similar to those of Hamburg. The asylum drains are carried to a sewage farm, the overflow water from this latter to the River Saale, and close below the mouth of the pipe lies the tube which carries Saale water to Nietleben. It is true that the water, before reaching the asylum, passes over a sand filter, which is an improvement on the state of things in Hamburg; but during the late and long-continued frost not only were the filter-beds quite frozen, but the sewage farm, too, was inactive. Thus, during the cold weather, the drain-water from the establishment went into the Saale unpurified, and returned to it enormously diluted, it is true, by river water, but absolutely unfiltered. No one will be surprised to hear that amongst the unfortunate

drinkers of this diluted sewage epidemic diarrhœa broke out. From where and how the first bacilli of Cholera Asiatica reached the asylum has not yet been cleared up, though there has been much talk of a male nurse from Hamburg.'

In the same number of the *Journal* it is stated that the bacilli of cholera had been found in the water supplied to the asylum. It is further stated that several cases of cholera had occurred at Trotha, a village on the right bank of the Saale, and two miles below the asylum.

It certainly seems to be almost incontestable that the proper course to pursue with regard to organic refuse—putrescible matter—is the very reverse of that which we do pursue. We clearly ought to encourage oxidation, and make putrefaction impossible.

Putrefaction is certainly a great cause of ill health. It was the putrefaction of wounds (now happily almost unknown) which converted our hospitals into something little better than charnel-houses. It is the putrefaction of organic refuse mixed with water in cesspools and sewers that causes that long list of ailments which we ascribe to the inhalation of 'sewer air.'

The opinion is held by many that the dejecta of typhoid patients and cholera patients do not become dangerous to others until putrefaction has set in, and such an acute observer as was the late Dr. Murchison held the opinion that common putrefactive changes taking place in dejecta were a sufficient cause of typhoid independently of the admixture of any specific poison.

The putrefaction of organic refuse, when mixed with water, has, there is reason to think, been the chief cause of the development of modern sanitary 'progress.' Our forefathers were not given to this method of treating putrescible matter. House-slops trickled along open

gutters, and excremental matters were deposited in dry pits. At the beginning of this century the water-closet came into use.

Mr. W. Haywood, quoted by Dr. Farr, says: 'Water-closets were invented about 1813, and became general in the better class of houses about 1828–33.[1] The custom at first obtained of building cesspools having overflow drains put below their doming, by which means the solid matters were retained and the supernatant liquid only ran off.

'In the year 1849, what may be said to be an organic change in the system took place. In 1848 the City Commission of Sewers obtained its Act for sanitary purposes, which became operative on January 1, 1849, and then for the first time was discharge into the sewers legalised. Previously a penalty might have been enforced for such a usage of them, but henceforth, within the City of London, those incurred a penalty who failed, upon notice, to construct the drainage of premises in such a manner as not to discharge all waste waters *and fæcal matters directly into the public sewers* [*i.e.* directly into the sources of water-supply], of which the full utility was therefore for the first time recognised by statute. This Act was speedily followed by others for the remaining area of the metropolis and for the entire country.'

'It will be noticed,' says Dr. Farr, 'that the deaths from cholera and diarrhœa increased in London in 1842, increased still more in 1846, when the potato crop was blighted, and in 1849 culminated in the epidemic of cholera.'

[1] According to a writer in the *Encyclopædia Britannica*, Joseph Bramah's 'first patent for some improvement in the mechanism of water-closets was taken out in 1783.' Some of the sanitary arrangements at Pompeii are very suggestive of 'water-carriage.'

Dr. Farr says, further, 'a system of sewerage is the necessary complement of a water-supply.

'Almost coincidently with the first appearance of epidemic cholera, and with the striking increase of diarrhœa in England, was the introduction into general use of the water-closet system, which had the advantage of carrying night soil out of the houses, but the incidental and not necessary disadvantage of discharging it into the rivers from which the water-supply was drawn.'

Mortality per 1,000 from diarrhœa in London (Dr. Farr):—

1838	·215	1853	1·011
1839	·201	1854	1·257
1840	·238	1855	·804
1841	·238	1856	·866
1842	·353	1857	1·181
1843	·410	1858	·759
1844	·340	1859	1·211
1845	·397	1860	·496
1846	·997	1861	·928
1847	·898	1862	·607
1848	·853	1863	·821
1849	1·705	1864	·981
1850	·813	1865	1·206
1851	1·085	1866	1·306
1852	·983	1871–80 –Dr. Ogle . .	·940

Thus in the decade 1871–80, 33,168 persons died of diarrhœa in London, the death-rate from this cause being ·94.

If the death-rate of 1838 (·215) had obtained in the decade 1871–80, the deaths from this cause would have numbered only 7,600, and there would have been a saving of 25,568 lives.

Since the introduction of the water-closet, and, probably, as a direct consequence of it, we have had four severe epidemics of cholera, a disease not previously known, and enteric or typhoid fever, previously almost

or quite unrecognised, has risen to the place of first importance among fevers in this country.

The evils which have arisen from cesspools and sewers have caused an enormous amount of attention to be devoted to what are known as 'sanitary appliances,' sewer constructions, &c., and so great and so well recognised are the evils of sewers that many of our friends are anxious that we should be compelled, by Act of Parliament, to protect ourselves from the mischief which previous Acts of Parliament have produced.

Not only does the putrefaction of organic refuse tend to fill the air of our houses and towns with foulness, but this mixture of organic matter with water is attended with other bad consequences.

This arises from the fact that much of the organic matter which we mix with water is distinctly poisonous. The zymotic theory of disease has of late years assumed more definite shape, so that we may now leave what was called the zymotic *theory* and consider the actual facts.

There is no doubt that the actual infective elements of many zymotic maladies consist of microbes, minute vegetable organisms belonging to the class known as Schizomycetes, that class which grows in organic mixtures.

These microbes are infinitely small; millions of them may live in a cubic inch of putrefying liquid. In favourable circumstances they will live for long periods. They will not only live but multiply, and it is at least a question, and a grave one, to what extent these infective germs undergo an increase when mixed with organic liquids, such as sewage or milk.

The fact that the zymotic poisons are *particulate and alive* is one which has most important bearings on the subject under discussion. If the poison were a

chemical poison, then dilution would practically do away with its power for harm. No amount of dilution is capable of destroying a zymotic poison; in fact, it is not impossible that the mere mixing of organic refuse, which contains a zymotic poison, with water may be the means of keeping it alive and possibly causing it to multiply.

When a mass of organic matter, charged with zymotic particles, is mixed with water and washed out of a house, the water will carry the poison with it whereever it may chance to flow or trickle, to watercourse, well, or any other source of drinking water; in fact, the dissemination is as perfectly and thoroughly done as if dissemination of poison were the main object which we had in view.

When dealing with organic matter impregnated with zymotic poisons, mere dilution with water increases rather than diminishes the danger.

As long as the poisonous organic refuse is concentrated, its repellent qualities are such that there is little chance of its gaining access to the human body. The microbes contained in it are theoretically capable of infecting an almost indefinite quantity of water, and this large quantity of water masks the repellent qualities of the stuff, and thus the danger of infection is greatly increased.

This dissemination of poison by water is one of which we have had very bitter experience in this country.

There is little room for doubt that, in this country at least, water has been the great carrier and disseminator of the poison of cholera.

In 1849 the mortality in London was highest in those districts getting their water-supply from the Thames between Battersea and Waterloo Bridge.

In 1853–54 the same phenomenon was observed. In 1866 the chief mortality was in the district supplied with water taken from the River Lea. With regard to this latter epidemic, we are in possession of many details, and the following is a summary of the facts as given by the late Dr. William Farr in his report on the cholera epidemic of 1866:—

'Several cases of cholera and choleraic diarrhœa had occurred over London in May; and on June 27, at 12 Priory Street, Bromley, one poor Hedges, a labourer, and his wife, both of the age of forty-six years, died of Cholera Asiatica, the former after fifteen, the latter after twelve hours' illness. These cases are minutely described by Mr. Radcliffe, who traces the discharges into a water-closet at 12 Priory Street, and thence 300 yards down the sewer into the Lea (a tidal river which ebbs and flows) at Bow Bridge, half a mile below the Old Ford reservoirs. He attaches great importance to these first cases, and they undoubtedly sufficed to pour into the sewers and waters millions of zymotic molecules, which day by day grew more and more frequent in the Lea, by every hour's choleraic discharges on both sides of the river.' A few days later water was supplied to the district from a reservoir the bottom of which was pervious to the waters of the Lea, and then resulted an outbreak of cholera and diarrhœa which caused the death of over 4,000 persons.

It is not necessary to give further instances of the dissemination of disease by water-carried sewage, sanitary literature is full of them.

What is true of cholera is also true of typhoid, and one need only say in reference to this subject that (if we accept, as we are bound to do, the statements put forward with regard to the cholera epidemic of 1866), if

the excreta of the Hedges family had been buried or burnt, the waters of the Lea would not have been infected, and possibly 4,000 lives would have been saved.

The first principle in dealing with epidemic disease is that which is expressed in the words *principiis obsta*—resist the beginnings. The object of this is evident, and is well expressed by Shakespeare in the words—

> A little fire is quickly trodden out,
> Which, being suffered, rivers cannot quench.

The mixing of bacteria with water may be looked upon certainly not as a resistance of the beginnings, but rather as a nursing and favouring of them, which, 'being suffered,' most surely 'rivers cannot quench.'

The real meaning of the doctrine of *Contagium Vivum* was brought home to the people of this country in 1902 by the outbreak of typhoid which was traced to the consumption, at a municipal banquet at Winchester, of oysters which had been taken from a sewage-befouled estuary. This epidemic affected many prominent citizens and was fatal to four or five of them. It has given a severe shock to the trade in oysters and other molluscs, and must to all thinking people bring home the occasional dangers of sea-bathing; for that which may settle on the oyster may equally settle upon the bather. This risk may be small, but the volume of sewage which is turned into our rivers is ever increasing, and it is recognised that the so-called bacteriological processes to which such sewage is subjected do not prevent virulent microbes from escaping with the effluent.

The great principle of *principiis obsta* has been most rigidly observed by surgeons in dealing with those forms of blood-poisoning which arise in connexion with wounds,

and which were known as 'hospital diseases.' To Lister belongs the credit of recognising that the great thing to be aimed at was the checking of putrefactive changes in the discharges from the wound, an end which has been attained by adopting what are known as antiseptic precautions in the treatment and dressing of wounds. A foul wound is looked upon as a great source of danger to the patient himself, and formerly the poisons generated in the wound of one patient were carried by sponges and instruments (which, be it remembered, were '*clean*,' as far as any indications appreciable by our unaided senses were concerned) to the wounds of others; and thus it followed that the mortality from what was wrongly spoken of as 'hospitalism' was enormous. Now, however, putrefaction in wounds is practically at an end, owing to the use of antiseptics and to an improved appreciation of what cleanliness really means; and, as a result of this, hospitalism has disappeared.

How marvellous have been the results which have followed on the adoption of the principle of preventing putrefaction in wounds is well shown in a table given in 'Erichsen's Surgery.' This table is taken from a statistical work by Max Schede on amputations, and shows conclusively what are the advantages of antiseptic precautions. The statement has been somewhat simplified for the sake of those who are not acquainted with medicine.

Uncomplicated Cases of Amputation

Cause of Death	Old treatment, 377 cases	Antiseptic treatment, 321 cases
Blood-poisoning	105	3

Thus it appears that the mortality from blood-poisoning

under the old treatment was 28 per cent., while with antiseptic precautions it fell to less than 1 per cent.

Antiseptic measures are used in other than purely surgical cases, and, to take one instance only, Sir John Williams has informed the author that since their introduction into the General Lying-in Hospital the deaths from that terrible disease, 'puerperal fever,' have practically ceased.

This great result has been brought about by attention to the leading principle of *principiis obsta*.

In former days the treatment most in vogue for wounds was 'pure' water; but now it is recognised that water is pre-eminently the encourager, and sometimes the main cause, of putrefaction, which of all things the surgeon tries to avoid.

The foulness of our rivers is largely due to the mixing of putrescible matter with water, *i.e.* to water-carried sewage, and there can be no doubt that, as water-carried sewage increases, the difficulty of obtaining pure water increases also. Water-carried sewage so fouled the Thames 'between the bridges,' that, after the bitter experiences of 1854, the in-take of the water companies was moved to a point above the tideway. Since then the population all along the Thames Valley has enormously increased, and if we who get our drinking water from the Thames escape disease, it can only be regarded as due to a happy accident, and not to the observance of any fixed principle to effectually prevent the fouling of the river. The precious liquid with which the author is supplied from the Thames costs nearly ten shillings per thousand gallons, and he is very careful to have every drop which is used for drinking purposes both boiled and filtered.

It is not possible to have much faith in the various

modes of 'treatment' which sewage undergoes in those establishments which local boards love to erect for this expensive amusement.

The addition of chemicals, if in sufficient quantity to destroy living organisms, must make the water still more unpotable than before, and can only be used by making the liquid so utterly nauseous that to drink it would be impossible.

Mere filtration unaccompanied by oxidation cannot be regarded as any safeguard after the experience of the Lausen typhoid epidemic, in which the poison of the fever filtered through a mile of earth, which was sufficient to check the passage of particles of wheat flour. Wide irrigation over a large area of land, as is practised in 'sewage farming,' is probably the best method of treating sewage, but this cannot be regarded as absolutely safe under all conditions, for reasons previously indicated.

If antiseptics have been previously added to the sewage, this must increase the difficulties of 'farming' with it, as, if the antiseptics have been added in sufficient quantity to destroy disease organisms, this would effectually check the growth of those other organisms upon which the fertility of the soil depends.

It is more than doubtful whether there is any absolute safety in obtaining water from deep wells. The Dudlow Lane well, near Liverpool, having a total depth of 443 feet, was fouled by percolation from cesspools, and percolation from a defective sewer would certainly prove equally disastrous. Surface wells are now not regarded as at all safe, but our suspicions with regard to them were not aroused until after the introduction of the plan of mixing water with putrescible matter. There was no soakage from an old-fashioned dry pit; there must be soakage from a cesspool or 'dead well.'

The only way of securing pure water is to make quite sure that there is no fouling of water-sources. If this were done, then pure water would be at once plentiful and cheap. It is now very dear, and is getting scarcer every day.

Dr. William Farr said, 'a system of sewerage is the necessary complement of a water-supply.' One would rather feel inclined to say that an extraordinary water-supply is the necessary complement of water-carried sewage, because with it our ordinary supplies quickly get fouled. In London we have effectually fouled all our wells, and the state of the Thames is such that a man must be in the very extremities of thirst or else insane before he would drink from the Thames anywhere between Teddington Lock and Gravesend, or partake of oysters or other molluscs which are deposited in its estuary. We have been warned of the possible dangers of eating those fish which are not gutted and cleaned before being cooked, such as whitebait (once the chief delicacy of the Thames), smelts, and sprats. The state of our noble river is a deep reproach to us, and must remind us day by day of the serious blunders we have committed. As long as it remains as it is, we certainly have no claim to be followed as an example in matters sanitary. London should rather serve as a warning, as did the drunken Helot to the Spartan youth.

The fouling of our sources of water-supply has driven us far afield for water, and this, no doubt, has been a great cause of the lessening of our mortality of late years, but it would be unwise to talk of security because we have had no serious epidemic since 1866, an absurdly short period in the history of a nation. It must not be forgotten that pure water is as necessary for animals as it is for man, and that, if we persist in

fouling our rivers, the poor farmer may have to pay a 'water-rate' for providing an artificial water-supply for his horses, cattle, sheep, and even poultry. Many diseases of animals are communicable to man, and it is daily becoming more evident that our health is very intimately bound up with the health of our animals, and that their sanitary condition is scarcely less important than our own.

From a financial point of view, water-carried sewage has not been encouraging. It has increased the rates, increased the cost of our houses, and put us to great expense for water. The 'treatment' of sewage before it is finally discharged into our rivers is everywhere an expense and nowhere a source of profit, and we find that public sewers which cost millions, cost thousands to keep them in repair.

The sewers we have built with borrowed capital. We have seized all the glory and patronage of disbursing enormous sums, and have left posterity to pay the bills. This is a doubtful policy, and a most immoral one, but it is of little use to raise one's feeble voice against the custom which is now so much encouraged of hanging a debt round the neck of our successors. It may be defensible to raise a loan for building town halls, schools, and similar edifices, of which posterity will reap the benefit, but to raise loans for the purpose of wasting most valuable fertilising matter by means of works which will be a constant expense, and never a source of profit, is a very doubtful policy.

It is to be hoped that the custom will soon obtain of compelling each generation to bear the charge of its own sanitary experiments—and blunders.

Sewers are constant sources of impoverishment to the soil, and the soil, be it remembered, is the only *per-*

manent and reliable source of wealth in any country. The waste of valuable matter which takes place in London and our big towns must make us blush. One could wish that this waste were limited to our big towns, but it is not so. It is common throughout the country, even in rural districts. Free trade has made food very cheap indeed, and cheap food, especially *imported* food, ought absolutely to increase the fertility of a country, for obvious reasons which need not be particularised. The fertility of this country is not increasing, to judge by the agricultural distress. The farmers are crying out for 'protection.' The first kind of protection needed seems to be a protection from ourselves and from the sinful waste of fertilising matters which local boards, municipalities, and Imperial Parliament equally foster.

If we made a proper use of our organic refuse we should enrich posterity. As it is, we reap and we do not sow. If municipalities would bury organic refuse, and plant the seed of some forest tree suited to the soil and situation (which in these days of cheap foodstuffs would probably be the best branch of agriculture to pursue), they would earn the blessings instead of the curses of posterity, and they would beautify the face of nature instead of making it hideous with tall chimneys, pumping stations, and precipitating tanks. This piece of advice will, just now, fall very flat, for of all agricultural arts forestry seems the deadest in this country.

As a defence for gigantic sewage schemes, it is often said that you can do nothing well without co-operation, and this is the excuse for compelling all, whether they want them or not, to contribute towards the cost of sewers.

If co-operation be for a good end, the result is a

great good; but if co-operation be for a bad purpose, the result is a great evil. I need say no more.

The last charge which has to be brought against water-carried sewage is a serious one—viz. that it encourages overcrowding in cities, which is universally admitted to be the greatest of all sanitary evils, and one which cannot be counterbalanced.

Water-carried sewage encourages overcrowding because it enables us to build houses with no outlet except a hole for the sewage to run through. The growth of London must be a source of alarm to sanitarians, and it is impossible not to admit that our system of sewers has been a most important factor in its production. Look at Charing Cross, where a street of gigantic clubs and hotels has arisen, each without curtilage of any kind, and where a handsome profit has been made by setting the first law of sanitation at defiance. You will find the same thing to a greater or less extent throughout the Metropolitan area.

In order to judge of the effect of overcrowding, let us look again at the vital statistics of the 'Strand' Registration District, which is about the centre of London, and from which one would have to walk very many miles to reach the country in any direction. But when we speak of 'The Strand,' it is very desirable to know what we mean.

'The Strand' is a name given (1) to a well-known street; (2) to a parliamentary division; (3) to a registration district; and (4) to a 'sanitary area.' The boundaries of these four Strands are all different, and it is essential to bear in mind that the 'registration district' and the 'sanitary area' are composed of very different elements. The following authoritative statement, kindly furnished to the writer by Dr. William Ogle, shows clearly in what this difference consists.

The Strand Sanitary Area or Board of Works District consisted of the following civil parishes :—

	Population 1891
St. Anne's, Soho	12,317
St. Paul's, Covent Garden	2,142
The Precinct of the Savoy	201
St. Mary-le-Strand	1,549
St. Clement Danes	8,492
The Liberty of the Rolls	421
	25,122

The Strand Registration District includes all the above parishes except St. Anne's, Soho, which is in Westminster District. It also includes the parish of St. Martin's-in-the-Fields, which is a separate sanitary area, and the Middle Temple, which forms part of the City of London, although not included therein or in any other area for sanitary purposes.

Population in 1891 of the Strand District		27,516
Deduct parish of St. Martin's-in-the-Fields	14,616	
" " Middle Temple	95	
		14,711
		12,805
Add parish of St. Anne's, Soho		12,317
Strand Sanitary Area		25,122

The 'Strand' Registration District enjoys many advantages. It is mainly a wealthy district, extending in irregular form from Temple Bar to Buckingham Palace. It includes the whole of the Green Park and half St. James's Park. It has a gravel soil, and slopes gently, with exposure to the south, to the fringe of (potentially) the noblest river in the country. The worst and poorest parts are at the north-east corner.

The true death-rate of a London district is difficult to get. The author has compiled a table by which one

is able to compare 'The Strand' with the county of Dorset (for ten years, 1871-80).

The county of Dorset has been chosen for comparison because it is a 'healthy district,' and if we are to do any good we must always aim at a high standard. Again, the Dorsetshire labourer has always been a favourite stalking-horse for cockney politicians, and it may be well to show how much healthier he is than the Londoner, notwithstanding the rustic's supposed condition of chronic starvation.

This table is very interesting. Dr. Letheby said 'a high death-rate means a high birth-rate, and a high birth-rate is the invariable concomitant of prosperity.' This dictum does not evidently apply to the Strand.

Dr. Farr, on the other hand, pointed out that 'a low birth-rate implies a small proportion of young adults and a large proportion of the aged.' This dictum again does not apply to the Strand, as we shall see by a reference to the next table, in which an endeavour has been made to make corrections for the abnormal age-distribution which obtains in that district, and which Dr. W. Ogle rightly insists is absolutely necessary before one can arrive at just conclusions.

The table speaks for itself.

From this table it appears that there was in the Strand Registration District during the decade 1871–80 a deficit of 3,812 children under fifteen, and of 453 of persons over sixty-five, while there was a surplus of 4,233 persons between fifteen and sixty-five.

This abnormal distribution ought, according to Dr. Farr, to give us a high birth-rate and a low death-rate. The very reverse is the case, and a critical examination of the figures seems to show that the death-rate in the Strand *is more than double what it is in Dorsetshire.*

'The Strand'—Mean Population 1871–80 = 37,461

Ages	Actual numbers living at each age	Normal age-distribution for a population of 37,500	Difference (+ & −) between actual and 'normal' numbers	Actual deaths in 10 years 1871–80	Deaths which would have happened if the distribution of ages had been normal	Death-rate at different ages	Death-rate of Dorset	Deaths which would have happened if the death-rate of Dorset had obtained in the Strand
Under 5	3,597	5,100	−1,503	3,596	5,100	99·97	40·07	1,440
5–10	3,134	4,500	−1,366	390	548	12·44	4·31	129
10–15	3,069	4,012	− 943	163	212	5·31	2·79	84
15–20	3,824	3,640	+ 190	317	299	8·29	4·43	167
20–25	4,426	3,337	+1,089	366	273	8·27	6·65	290
25–35	6,773	5,512	+1,261	963	770	14·22	7·50	510
35–45	5,121	4,237	+ 884	1,246	1,000	24·33	10·48	525
45–55	3,935	3,225	+ 710	1,338	1,088	34·00	13·04	520
55–65	2,311	2,212	+ 99	1,147	1,100	49·63	24·56	565
65–75	1,003	1,237	− 234	754	900	75·17	55·28	550
75	268	487	− 219	425	774	158·58	151·71	403
	37,461	37,500		10,705	12,074			5,203

In this chapter we have attempted to show that the systematic admixture of putrescible matter with water is inadmissible—

1. Because it is antagonistic to the methods of nature, encouraging putrefaction and delaying nitrification, and there can be no successful antagonism to nature.

2. Because the putrefaction set up in cesspools and sewers by mixing water with putrescible matter has been a direct cause of much disease.

3. Because the practice involves the most perfect dissemination of disease particles, and a neglect of the great principle, *principiis obsta*.

4. Because it is the great cause of the fouling of

rivers and wells, and makes the obtaining of pure water increasingly difficult.

5. Because it is financially and economically disastrous, crippling the ratepayers and exhausting the land.

6. Because it is one of the chief causes of overcrowding, the greatest of all sanitary evils.

It may be asked, 'What useful purpose can be served by demonstrating these matters to Londoners? London is hopelessly committed to the principle of water-carried sewage, and must make the best of it.'

The obvious reply is that even London should not heedlessly increase her already insurmountable difficulties, and that happily the whole of England is not yet quite absorbed into London and other cities. There is a very general belief throughout the country that because London has adopted the system of water-carriage it must therefore be the best. This idea is unthinkingly adopted, and to its adoption the distinction of borrowing and disbursing a large amount of other people's money acts as a spur.

There has come within the author's own knowledge the case of a country town, in the midst of a poor agricultural district, which clamoured for a 'sewage scheme' for the purpose of polluting its sparkling watercourse, where anglers pay large sums for the privilege of trout-fishing, its death rate being at the time between sixteen and seventeen.

In the Thames Valley, the region of villas and market-gardens, a whole crop of 'sewage schemes' have lately been put forward, notwithstanding that the more rational methods of sanitation would be easier and cheaper.

A few years since the author visited a lone farm-house which a friend wished to take for the summer,

and found that the proprietor, having taken the soil-pipe of a recently erected water-closet into a cesspool alongside a deep well sunk in the chalk, had rendered his house unlettable to any thinking person; and finally he would instance the case of another friend who took a moor in Scotland, and wished to have rational methods of sanitation, but the noble owner, bitten by the modern craze for water, would allow nothing but water-carriage, and accordingly laid his filthy pipes to foul the babbling Highland burn, and deprive the soil of that of which it was in need.

Again, in institutions such as workhouses, barracks, schools, and the like, water-carriage is often adopted, notwithstanding the favourable conditions for rational methods. The ignorance of soldiers in this matter is an acknowledged cause of the sickness and mortality during campaigns.

There seems, in short, a very great necessity for directing attention to the 'shortcomings' of water-carried sewage.

CHAPTER IV

HYGIENIC UNITS—THE LIVING EARTH—THE CIRCULATION OF ORGANIC MATTER

As a sequel to the study of overcrowding in cities it seems advisable to say a few words on what may be spoken of as

Hygienic Units

The prime hygienic unit is necessarily the individual man, and the problem which sanitarians have to solve is how to provide this individual with pure air, pure water, food, and raiment. The individual requires a definite average amount of pure air, a definite average amount of pure water, and a definite average area of the earth's surface for producing his food, clothing, and other necessaries. It may not be unprofitable to consider these units of air, water, and earth in relation to the individual, because it will be evident that our ability in the present day to practically neglect one of them causes serious difficulties in dealing with the other two.

Human life is only possible on the condition that a certain area of the surface of the earth be dedicated to its support.

Pope has drawn a charming picture of the recluse

> Whose herds with milk, whose fields with bread,
>   Whose flocks provide him with attire,
> Whose trees in summer yield him shade,
>   In winter fire.

And since all the necessaries of life come from the earth, it seems but natural to ask the question: What area of ground is necessary for the support of a man?

Although this question must be fundamental when discussing matters of practical hygiene, it is, nevertheless, not capable of any exact answer.

If we speak of the area necessary for the support of an individual as an earth unit, it will be at once evident that the unit must vary in size with the fertility of the ground and the latitude in which it exists, because more food, firing, clothing, and housing are required in cold climates than in hot ones. It would be very hazardous to make any calculations for practical application, because the fertility of the soil varies, and the unit which might be sufficient in a year of plenty would fail to support its owner in a year of scarcity.

Theoretically, an island like England should support a very large population, because, being surrounded by the sea, an inexhaustible source of food is within reach of all.

A soldier on service is said, according to Parkes, to need about 31 oz. of dry food per diem, of which 18 oz. should be carbohydrates, 7 oz. proteids, 4½ oz. fats, and 1½ oz. salts. Now, 30 oz. of oatmeal contain about the requisite quantity of carbohydrates, together with 3½ oz. of proteids and 1½ oz. of fat. If, therefore, a man had 2 lb. of oats per diem, and were allowed fish *ad lib.* for supplying the deficiency of proteid and fat in the oatmeal, it is theoretically conceivable that he might continue to exist and work. If we take the yield of oats per acre at 50 bushels, weighing 40 lb. per bushel, this gives us 2,000 lb. of oats per acre; and if 2 lb. per man per diem be sufficient (with the addition of fish) to support life, it is evident that each man, requiring 730 lb.

of oats per annum, needs rather more than one-third of an acre for his food-supply. Although it is well known that oatmeal and herrings formerly constituted the staple food of the Scotch peasantry, and still form no inconsiderable portion of their diet, this third of an acre must be looked upon merely as a theoretical minimum, and is brought forward for the purpose of enforcing the self-evident fact that a certain area of ground is necessary for the support of each human life.

Although agriculture advances with civilisation, and the productiveness of the soil is capable of being increased to a very decided extent, yet it is probable that the needs of civilised man more than keep pace with the improvement of the soil, and as all the paraphernalia of civilisation come directly or indirectly from the soil, it is certain that the higher the state of civilisation, the greater is the area of soil necessary for the support of the man. Be it remembered that our complicated clothing and highly finished dwellings are, equally with our food, all productions of the soil.

Our theoretical minimum is calculated for a subsistence diet for a man in full work, and if, bearing in mind that a man must be clothed and housed as well as fed, we double this theoretical minimum, and treat men, women, and children all alike, it is probable that this two-thirds of an acre would be a sufficient area of cultivable land for the bare support of each unit of our population.

Of the 37,000,000 acres of England and Wales, about 28,000,000 are cultivable, and as the population of England and Wales is about 32,000,000 it seems probable that, if our foreign supplies were stopped, we might, with the help of our inland and sea fisheries, manage for a

time, at least, to support our population on home-grown produce. The Chinese are credited with supporting a very large population in proportion to the area of cultivable land in the country, and although we have very little certain knowledge, it is on all hands admitted that the population of China is exceedingly dense, that the Chinese export a very large quantity of home-grown products, of which the chief are tea and silk, and that their importation of food-stuffs is insignificant. The Chinese are probably the most hard-working, contented, and thrifty people in the world, and they are probably ahead of all other nations in their knowledge of practical agriculture and pisciculture, and it is, of course, to their advance in these matters that the possibility of feeding so large a population on home productions is greatly due.

Although the human population in China is very large, the animal population is not so great in proportion. In England the horses, cattle, sheep, and pigs are collectively more numerous than the human population, but in China this is not the case. Almost all the labour which with us is done by horses or by steam, is in China done by human beings, and the soil is made to a great extent to produce food for man without the intermediate action of live stock. These facts in a large degree explain how it is that such a numerous population is sustained. It also explains the opposition of the Chinese officials to the introduction of railways and steam machinery. Almost the only source of force in China is human muscle, and as this astute race is not likely to be deluded into the belief that steam machinery can *create* force, and as the people are contented and peaceable, and as their trade goes on steadily instead of by fits and starts, with booms and strikes, they are naturally unwilling to introduce machinery which must have the effect, as

it has had with us, of dislocating their industries, and must bring about a complete change in the habits of the people. The Chinese seem to adhere to the maxim, 'Let *well enough* alone.'

When we speak of the dense population of China, it is well to remember that the Chinese live upon one plane, and that the population is not piled up in houses storey upon storey, as with us. This living upon one plane has the effect of bringing the population very much *en évidence*, but it is not possible to have the same amount of overcrowding under these conditions as is to be found in the leading cities of Europe and America. The city of Pekin contains about sixty persons to the acre, and when viewed from the top of the walls it is said to present the appearance of a city of gardens.

In England and America the discovery of the steam-engine has led to an excessive concentration of population in certain localities for manufacturing purposes, and in order to feed these urban populations it has been found necessary in Great Britain to remove all restrictions on the importation of food; and thus it has come about that the agriculturist has had no share in the commercial prosperity of the country: the artisan has been artificially fattened, and the agriculturist has been starved, and it is in no way surprising that the latter should wish to change from the plough-tail to the workshop, and thus increase the competition with which artisans have to contend. The land which is necessary for the support of the British individual is nowadays scattered about the globe, and may be at the Antipodes. It is usually completely out of sight, and the consumer of imported food seldom gives a thought as to how and where it was produced. Imported food is so cheap that the high cultivation of our own country has ceased to be a matter of

prime importance, and there being but little demand for organic manure, we have begun to burn so much of the refuse of our cities as is combustible, while the rest is used to destroy our fisheries, poison our molluscs, and block our ports. What the end will be it is not difficult to see.

The fertility of a country which imports a large proportion of its food ought, if a rational use were made of excremental and other refuse, to increase, and the ability of the land to support life should increase with it; but in England there has been for years a gradual process of agricultural degradation, and corn-lands which supported human life have been largely converted into pastures for the support of the lower animals.

Owing, so to say, to the neglect of the earth unit and the extraordinary and unprecedented concentration of population in certain localities, we are beginning to experience difficulties in supplying the individual with his unit of water.

The London County Council once stated that any scheme for the supply of water to its district must, in order to be efficient, be calculated on a minimum supply of 35 gallons per head per diem for a population of 12,500,000! Not only was the Council apparently endowed with the spirit of prophecy, but it seemed to contemplate a concentration of population on the area which it controls three times greater than that which obtains at present. If, instead of sixty-five persons to the acre, we are eventually to have 195, and if the Council is going to do everything to encourage and nothing to check this fearful concentration, it is evident that the public health must steadily deteriorate.

However, let us accept the figures and see what they mean. Thirty-five gallons for 12,500,000 is 437,500,000

gallons a day, and close upon 160,000,000,000 gallons per annum. This amount of water is nearly one-third more than that which is calculated to flow over Teddington Weir. Having fouled one Thames until it is dangerous to drink of it, London is crying for a second. The question is, Will it get it?

This question of water-supply for our big centres of population has of late years become rather urgent, and is likely to occupy public attention for some years to come. The fact that London and Birmingham have both fixed their eyes on the same source in the Welsh hills, and that Birmingham was the first in the field and has compelled London to look elsewhere, is one to make us ponder the whole question rather seriously. Glasgow has taken Loch Katrine, Liverpool has taken Lake Vyrnwy, Manchester has appropriated Thirlmere, Birmingham is looking to the Welsh hills, and all these towns have expended, or are seeking to expend, enormous sums on the erection of municipal waterworks. This, of course, has to be done with borrowed money, and as our successors will have to pay a great part of our bills, it is very necessary to be sure that posterity will reap a benefit as well as a liability.

The great aim of the sanitarian should be to prevent overcrowding, and it at once becomes a question whether, regarded from the national point of view, it is better to allow populations to settle in spots where water is to be obtained, or by the expenditure of millions on great engineering schemes to bring the water to certain spots, and thereby quietly encourage overcrowding, with all the physical and moral degradation which it entails. There can be no doubt that the bringing of water under pressure in large quantities to any given spot tends to increase the rateable value, and is good for the landowner

and the manufacturer, but whether it is of benefit to the public health is, to say the least, doubtful.

That it is the duty of sanitary authorities to stop the pollution of rivers and other sources of water there can be no doubt, but this is a duty they practically never perform, because it is a disagreeable one, and brings them into conflict with individuals.

The duty of a sanitary authority to provide pure water is interpreted as an injunction to embark on a huge speculative business with thousands or millions of borrowed capital – a speculation in which posterity runs the risk and the directors incur no responsibilities. This is a proceeding very dear to the heart of the average councillor, and is naturally popular, because it is considered to be 'good for trade.' The amount of water required per head is, in these modern times, very large. The inhabitants of London consume about 30 gallons per head, which is slightly below what is considered necessary—35 gallons per head being the amount which is at present accepted as sufficient. This number is, of course, an average, and includes the water used for animals as well as man, for municipal and manufacturing purposes, and also for power, such as the working of hydraulic lifts and the driving of light machinery; and it is to be noted that the use of water as a motor is on the increase. Great as is the amount of water used per head, it is likely to be greater in the future.

Now, all the water which is available for our consumption has its origin in rain, which, falling upon the earth, percolates through it, to appear again in the form of springs, or finds its way along the lines of surface drainage to the lakes and rivers. An inch of rain is equal (approximately) to 22,000 gallons per acre (actual number, 22,624), so that an annual rainfall of 30 inches

gives 660,000 gallons of water per acre. If this quantity of water falls upon cultivated land, what amount of it will percolate through the upper strata of the soil and find its way to the wells?

This is necessarily a difficult question to answer, and must depend upon the character of the soil and the nature of the growth and crops upon it. The draining of land *upwards* by means of the roots of plants and the evaporation carried on by the green leaves is so great that no water can possibly be added to the subterranean stores during the period of growth—*i.e.* from the middle of March to the middle of October; and this fact, which is generally recognised, finds expression in the saying (common in many parts of the country), that 'the springs never rise until after the first frosts of autumn' —*i.e.* until the green leaves have been killed and their large evaporating surface abolished.

Sir John Lawes and Sir H. Gilbert, by their experiments on rainfall and percolation, carried on at Rothamstead, have shown that of the rain falling upon the bare earth the amount lost by evaporation is tolerably constant. At Rothamstead this amounts to about 17 inches per annum, so that with an annual rainfall of 30 inches about 13 inches will percolate the soil and 17 inches will be evaporated. These results, be it remembered, are those obtained with bare soil and with the soil of Rothamstead, but the relative amounts of percolation and evaporation will necessarily vary with the character of the soil and the amount of vegetation.

Mr. C. Greaves, who carried on experiments at Lea Bridge for a number of years, showed that of 25 inches of rain falling upon pure sand, about 21 inches would percolate the soil and 4 inches would be lost by evaporation; but if the same amount of rain fell upon turfed

soil, the percolation would be not much more than 7 inches, and the evaporation would amount to 18 inches. Mr. Greaves also showed that the yearly evaporation taking place from a surface of water amounted to over 20 inches.

To estimate the effect of vegetation on percolation is necessarily difficult. The final judgment of Sir John Lawes and Sir H. Gilbert in the matter is given in remarks made by the latter at the Institution of Civil Engineers in March 1891. Sir H. Gilbert said: 'It was difficult to estimate exactly what deduction should be made for vegetation. A large proportion of any area they had to consider was covered with vegetation. Sir John Lawes and himself had considered that the minimum amount would average 2 inches, as in the case of downs and waste lands, where there was very little vegetation; whereas, with a heavy grain crop or good mangel crop, there might be an evaporation of 7 inches or more. Taking the average of a large area round London, partly covered with vegetation and partly bare, over a large number of seasons, they thought that between 3 and 4 inches should be deducted from the 14 inches of percolation, so leaving 10 or 11 inches. Supposing the average rainfall to be about 30 inches, that left about 19 or 20 inches for evaporation by the soil and by vegetation. This agreed very fairly with the results of Dr. Evans and others.'

These remarks were made *à propos* of a paper by Mr. Thornhill Harrison 'On the Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London;' and Sir John Lawes, in a communicated note, drew attention to the fact that at Rothamstead there was evidence that one river had disappeared, that the River Ver was dwindling, and that

the wells of the district had frequently to be lowered. The water-supply in the district was diminishing, they wanted all they could get, and certainly they could spare none for the necessities of London.

It may be interesting to add that analyses of the rain-water collected at Rothamstead have given as the most recent and trustworthy results 0·248 part of nitrogen or ammonia per million of water. The extremes observed were 5·491 and 0·043 per million, the variations being dependent on the richness of the atmosphere in ammonia and on the quantity of the rainfall, the smaller deposits containing the larger proportion of ammonia. The summer rains are generally richer in ammonia than the winter rains. Estimations of chlorine and sulphuric anhydride, made at the same time, give 1·99 and 2·41 parts per million.

If we estimate that one-third of a rainfall of 30 inches may be stored for future use, we shall probably be in excess of the amount. To get, however, at the exact amount is less important than to recognise the fact that water is a limited commodity, and that so soon as population exceeds a certain density it becomes necessary to go far afield for water.

If in London each individual be supplied on an average with 35 gallons of water per diem, this amounts to something over 12,000 gallons.

Of the 660,000 gallons which fall on each acre of ground in London, we have reason to think that not more than 220,000 gallons are stored, so that at our present rate of consumption we could not accommodate much more than eighteen persons to the acre, supposing such persons to be dependent for their water upon private wells.

Very early in the history of every city it has been

found necessary to bring water artificially from the outskirts to the centre.

London in ancient time not only had the Thames running through it from west to east, but it was intersected by a number of smaller streams. We read of Langbourne, Sherborne, Wall Brook, the Fleet River, Old Bourne, Tybourne, Ay Brook, Westbourne, and Bayswater. The names of these various streams are practically all that remains of them; the streams themselves have disappeared long since. Let us take the case of the most important of these streams, the River Fleet, which was formerly a river of some size, by which barges of large tonnage could get as far as Holborn, at the spot where the Viaduct now is. The Fleet rose at the foot of Highgate, and flowed through St. Pancras, to enter the Thames at Blackfriars. In the first place much of its water was diverted to supply conduits for the City, and this, combined with the drainage of private wells sunk by the ever-increasing population along its course, had the natural effect of largely diminishing the bulk of the Fleet River, which came to be known as the Fleet Ditch. A part of the water diverted from its source returned to it near its mouth in the shape of sewage and surface drainage, so that the shrunken waters of the Fleet Ditch became too foul to be tolerated by human sense. It was accordingly closed in and converted into a sewer, which now empties into the great intercepting sewer on the north side of the Thames. The waters of the Fleet River are now discharged into the Thames at Barking. The same thing has happened to all the other tributaries of the Thames in the London district: their shrunken waters are enclosed in sewers and conducted to Barking, a point many miles lower down than their natural point of entry into the Thames.

The dislocation of Thames water which has taken place, and is still going on, is prodigious. Every gallon of water pumped from the Thames or from wells sunk in the Thames Basin diminishes, slightly but surely, the volume of the river.

The 200,000,000 gallons which are distributed daily by the London water companies, although not all derived from the river itself, are in reality abstracted from the Thames or its tributaries, and tend to diminish the bulk of the river. In addition to this, the rain falling on the metropolitan area (118 square miles) finds its way for the most part into the sewers, and instead of replenishing the Thames in its metropolitan course, is all conducted to Barking.

Again, one must remember the enormous increase of population in the Upper Thames Valley, between Oxford and Kingston. This population is supplied with water abstracted directly or indirectly from the Thames, and this further assists to diminish the bulk of the river, although a great part of this water is returned to the river in the form of sewage. That the bulk of the river is seriously diminished is shown by the fact that it has become necessary to build a new lock below Richmond in order to carry on the navigation. The shrinkage of the Thames has been less appreciable in London than otherwise would have been the case because of the narrowing of the stream by the Thames Embankment. Thus we have in London the demonstration that the supply of water is strictly limited, and is simply proportionate to the area which is drained by the source of water (be it well, spring, river, or lake) selected for the supply.

We have in London, also, a demonstration of the old proverb that 'one cannot eat a cake and have it,' and that if we pump the water from a river or the springs

supplying such river, the bulk of such river must be diminished. The commercial prosperity of London is due to its situation on the Thames, which has afforded unrivalled facilities for inland and foreign trade, and there can be no doubt that, in spite of steam and railways, the maintenance of our silent highway is still of paramount importance. We have seen that the bulk of the river between Teddington and London is already so shrunken that we have been compelled to block the way of our inland navigation by a lock and weir below Richmond, and there can be no doubt that the *débris* and sludge of the sewage of some five million people cannot fail to block the way of our outward navigation. But the more money that is paid for steam-dredging, so much the better for that particular trade; and the more difficult becomes the navigation of the Thames, so much the better for the railways. This may be 'business,' but it is not 'thrift,' and there can be no doubt that modern business and old-fashioned thrift are like the hare and the tortoise of the fable, and that, in the long run, slow and steady will win the race. This opinion is not likely to be shared by those who are under the delusion that the steam-engine can *create* force, instead of merely storing or transforming it, and that the wind and tides, and that most perfect of all machines, the human hand, are unable to compete with steam.

Wells within the area of a city are so certain to get fouled by the subterraneous tricklings from sewers and cesspools that it has become the fashion to compulsorily close them. Thus it comes about that the actual area occupied by a city is not available for water-supply, and the 16,000,000,000 (sixteen thousand million) gallons of water which would be yielded by wells upon the 118 square miles occupied by London are discarded as a

beverage because they have percolated through the London soil. Big cities render their own area unavailable for water-supply, and consequently they have to look to other areas.

What must be the area of the gathering-ground set aside for the supply of 160,000,000,000 (one hundred and sixty thousand million) gallons of water per annum? This must depend upon the character of the soil and the rainfall of the district. If it be sought to obtain this amount from wells in the London district, it is evident that about ten times the present area of London would be necessary, or about 1,180 square miles of country. If this amount is to be brought from a district with a big rainfall (say 60 inches per annum, of which 40 would be available for storage), then a quarter of this amount, or 295 square miles, will be sufficient. In the latter case the water will be gathered from uplands, and the ground will have to be purchased outright and thrown out of cultivation, because high manuring will be dangerous to those who drink the water. Lands have been afforested, a church and village submerged, in order that Liverpool may drink. Birmingham, Manchester, and London are anxious to imitate this example. What would be said of an absolute monarch who, having wilfully fouled his streams, destroyed a church and village in order to form a reservoir for his aqueduct?

It thus appears that a city reduces much land to a state of agricultural degradation.

First, the land upon which the city is built becomes agriculturally unproductive.

Secondly, the gathering-ground for water-supply must not be highly cultivated if the water is collected by gravitation of surface-water to a lake.

Thirdly, land is needed for the purification of the sewage, the extent of which must depend upon the amount of water-supply. This land will produce nothing but rye-grass, and is, therefore, in a state of agricultural degradation.

The preceding paragraphs demonstrate the almost self-evident truth that, in order to live, we must each of us have a certain area of land, and figures have been quoted to show that in this country about two-thirds of an acre per individual might be sufficient. If the individual live on his land, he will certainly get enough fresh air and more than enough wholesome water from a well sunk in it. All refuse of every kind would be returned to the land in order to maintain and increase its fertility, and finally he might be buried in it. The life of this imaginary person might not be luxurious, but his hygiene would be complete; the privacy of his home would not be invaded by a 'Board,' and there would be no sanitary rate nor burial rate.

The person living in a city needs more land than our imaginary hermit, because, in addition to the area which he occupies, and which he needs for the supply of his food and clothing, he must have land appropriated for water-supply, purification of sewage, and burial.

Whether or no these figures and calculations as to the amount of land necessary for the support of the individual be absolutely correct is a matter of not much importance; but it is certainly interesting to arrive at the paradoxical conclusion that the inhabitant of an overcrowded city really requires more land for his support than the country cottager, even assuming that their needs for food and clothing are identical.

The difficulty of supplying a proper quantity of *fresh*

air in overcrowded cities does not need any lengthened discussion.

Sanitation in large cities is, at the best, a makeshift, and no high level of health is attainable in a place where the chief object of hygienists seems to be to enable persons to live as densely packed as possible.

Those, therefore, who live in the country, and who enjoy the luxury of elbow-room, should hesitate before they hastily copy the sanitary methods of the town, and heedlessly begin to foster overcrowding, the bane of all sanitary and social virtue.

These remarks are addressed to dwellers in the country, because the subject—the 'Living Earth'—is one which those who live on paving stones, tarred blocks, asphalte, or macadam have to take upon trust.

The Living Earth

The 'Living Earth'! Some may ask what is meant by this, and whether the epithet 'living' is applicable to the dark-coloured, inert mould which the countryman sees in the fields and gardens, and the town-dweller finds in the flowerpot which holds his struggling geranium.

The reply is in the affirmative. We have arrived of late years at a certain knowledge of the fact that the mould which forms the upper stratum of the ground on which we live is teeming with life, and this fact is one of prime importance to sanitarians.

It has long been recognised by agriculturists that the upper stratum of the soil differs from that immediately below it in fertility; and in treatises on gardening (notably in that admirable work written by William Cobbett nearly seventy years since) the warning is invariably given to be careful in trenching, not to bury

the top spit of soil beneath the lower spit, because the top spit is by far the more fertile. The fertility in this case was supposed to be due to prolonged exposure to air, and the lower stratum of soil, if brought to the surface, would only become fertile after a considerable interval. It is interesting to observe that, although these early writers were unacquainted with the whole truth, they had grasped the most important fact, and their practice was sound. This is often the case, and it may be regarded as certain that we act rashly when we hastily abandon the custom of centuries, because some new fact dazzles us and distorts our vision.

In connexion with William Cobbett, one may draw attention to a term which he uses more than once in the work referred to, viz. the *Fermentation* of the soil. Cobbett tells us that the earth begins to ferment in the spring, and that, before sowing, a thorough tilling and mixing of the upper layers of the soil are very necessary, with a view not only to the disintegration of the soil, but to a thorough leavening of the whole mass with fermentable matter. There is no doubt that this term 'Fermentation' as applied to the soil is perfectly apt, as we shall find further on.

The black vegetable mould which lies upon the surface of the earth is largely composed of organic matter, which is not to be wondered at, seeing that every organised thing, whether animal or vegetable, which inhabits this globe, falls, when dead, upon the earth, and becomes incorporated with it.

This black vegetable mould is largely composed of excrement, for not only is the excrement of the larger animals being constantly added to it, but this and the varied organic débris which compose it pass repeatedly, probably, through the bodies of animals which inhabit

the earth, and especially of earthworms. Darwin, in his book on Vegetable Mould and Earthworms, has forcibly drawn attention to the enormous amount of work which worms perform in the aggregate. How they disintegrate the soil. How they riddle it with burrows, which admit air to the deeper recesses of the soil. How their castings, which are incessantly being thrown off, tend to level inequalities, and gradually to bury stones or whatever dead inorganic matter is incapable of solution, digestion, or disintegration. Earthworms are found almost everywhere, and they are probably the most important of the animals which live in the soil, but it need scarcely be said that there are many others, and every one who has a garden must recognise the fact that gardening is only carried out at an enormous sacrifice of animal life, for with every thrust of the spade into rich garden mould a death-blow is dealt to many of its inhabitants.

The disintegration and aeration of the soil, which is effected by the quiet tillage of the earth-dwellers, is of the greatest importance to the agriculturist, for it is hardly conceivable that the delicate rootlets of plants could grow and extend unless the soil had been softened and pounded by the digestive fluids and the gizzards of the earthworms and their neighbours.

Seeing, therefore, that agricultural mould has all passed through the bodies of worms, and much of it through the bodies of other animals antecedently, we shall not be wrong in insisting that this so-called vegetable mould is mainly an animal excrement. The peculiar, sticky, glutinous quality of rich mould when moistened is probably in part due to this fact.

Although the amount of *Animal* life in the earth is considerable, it is as nothing compared with the richness of the soil in the lower forms of *Vegetable* life. The

dead and excremental matter becomes the food of minute vegetable organisms, which abound in the soil to a very great extent. This must be the case, for we know that saprophytes and their allies abound everywhere, and as the surface of the earth is the common reservoir of all forms of life, it follows that these low vegetable microbes must be more abundant in the earth than elsewhere, and more abundant at the surface than deeper down. In Watson Cheyne's edition of Flügge's work on micro-organisms (New Sydenham Society, 1890) this is very clearly stated: 'Enormous numbers of bacteria have always been found in the soil by the most various observers. Infusions made from manured field and garden earth, even though diluted 100 times, still contain thousands of bacteria in every drop, and the ordinary soil of streets and courts also shows the presence of large numbers. Bacilli are present in much the largest numbers; but in the most superficial layers, and in moist ground, there are also numerous forms of micrococci.'

These micro-organisms of the soil are very active in producing changes in organic matter added to the soil. These changes are usually in the direction of oxidation, occasionally the change is one of reduction. One thing is certain, that if the soil be sterilised by heat or other means, it is no longer capable of producing any chemical change in organic matter. This seems to be a fact of prime importance to the sanitarian. The oxidation and nitrification of organic matter in the soil is a biological question, pure and simple. It is an effect produced by the *living earth*; a process analogous to fermentation, which Cobbett seems to have appreciated.

Whether the nitrifying process which takes place in the soil is due to one or to many varieties of microbe is not settled, but the latter supposition is probably correct, and

experiments seem rather to point to the conclusion that, given favourable conditions—the free admission of air to a soil which is not unduly moistened—nitrification will go on. Many attempts have been made to isolate a nitrifying organism, and one of the latest, by Professor Percy Frankland and Mrs. Frankland, the results of which were communicated to the Royal Society in February 1890, appears to have been successful, for these observers isolated a 'bacillo-coccus,' the power of which in producing nitrification appears to be most remarkable. Whether this bacillo-coccus is one of many having similar power, or whether it stands alone, is not known.

It has been asserted that mould fungi are also active in producing the disintegration and oxidation of organic matter in the soil. It is possible, however, that the *Bacillus mycoides*, which forms threads closely resembling mycelium, has been mistaken for mould fungus. This bacillus mycoides is one of those which is constantly present, we are told, in garden soil.

It has been conclusively shown by Flugge, Koch, and others that the microbes are most abundant in the superficial layers of the soil, and that they tend to disappear in the deeper layers. They are practically absent in the deeper layers, unless the earth has been deeply stirred or trenched, or unless sewer or cesspool has conducted filth to the deeper layers without touching the superficial ones.

'Numerous filtration experiments on a large and small scale have shown most distinctly that a layer of earth ½ to 1 metre in thickness is an excellent filter for bacteria, and hence the purification of fluids from bacteria must be still more complete in cultivated, and especially in clay soil, and where the fluid moves with extreme slowness. Further, it has been repeatedly shown that wells which are properly protected against

contamination, from the surface and from the sides, furnish a water almost entirely free from bacteria; that further, wells of water containing bacteria become the purer the more water is pumped out, and the more ground water comes in from the deep layers of the soil.'

The vegetable living mould on the surface of the earth is in short a filter of the most perfect kind. It is very rich in saprophytic bacteria, whereas the subsoil at a depth varying from 3 to 6 feet is barren of bacteria, as well as of other kinds of life. The subsoil is mineral, inorganic, and dead; the mould upon the surface is organic, and teems with life.

It seems to be an undoubted fact, and one which in sanitary matters is fundamental and of the greatest practical importance, that, *from the point of view of microbial life, the first few inches of the soil are, so to say, worth all the rest.*

Anything which is thrown upon the surface of the ground soon disappears.

This is especially the case with water. The absorbing power of soil for water varies according to its mineral constitution. Loose sand and chalk absorb water very readily, and clay less readily, but the absorbing power of vegetable mould, or humus, as it has been called, is infinitely greater. Humus is said to be able to absorb from 40 to 60 per cent. of water, and to hold it very tenaciously. This is from two to three times as much as the most porous dead mineral soil is capable of absorbing. We all know that in times of heavy rain it is infinitely rarely that we see water lying in pools on the surface of cultivated soil, whereas it soon collects on roadways and paths, which are made of dead mineral matter. The tenacity with which mould retains water is due to the fact that the water is absorbed into the interior of millions

of vegetable cells, and is not merely held by capillary attraction in the interstices between small mineral particles. It is the swelling of individual cells which forms so effectual a barrier to the passage of bacteria.

Not only water, but everything else when thrown upon the soil, disappears sooner or later. Such things as pieces of wood, horn, or leather, about the toughest of organic materials, become softened and permeated by fungoid growth, and finally crumble away. In some parts of the country, rags of all kinds are largely used for manure. Through the autumn and winter these may be seen lying on the surface, but when in spring the tilling of the land goes forward, and the fermentation of the soil commences, the coarsest of these rags disappear. If wood, leather, and rags disappear, leaves and animal excrement disappear, as we all know, far more readily. The disintegration is forwarded by birds, insects, worms, and their allies, and what was the excrement of a large animal becomes, as it were, the excrement of many small ones, until finally, by the action of saprophytes and fungi, these organic matters become fertile 'humus,' which is the only *permanent* source of wealth in any country, the source whence we derive all the materials for our food and clothing.

The question whether among the bacteria which are found in the soil some may not be hurtful to mankind, is a question of great interest and importance. If disease-causing organisms find their way into the soil, may they not multiply or at least continue to live, and then prove a danger to health? There can be no doubt that pathogenic organisms do exist in the soil, but their power for harm would seem to be practically very small indeed; and to regard the soil as dangerous because some pathogenic organisms may lurk in it, would be

about as rational as it would be to condemn vegetable food because of the occasional dangers of hemlock, aconite, or the deadly nightshade. It is well known that if soil be inoculated into some of the lower animals, such as guinea-pigs, fatal results will follow from malignant œdema and tetanus; and also that earth, and especially street-mud, if ground into wounds in the human subject, may cause similar diseases, and the death of the victim. It is equally well known, however, that the workers of the soil, agricultural labourers and gardeners, are amongst the healthiest classes of the community, and that they are not credited with any diseases which are special to their calling. The disappearance of malaria as a real soil-poison and its proved dependence upon the mosquito is the last interesting discovery in this connexion. It seems to be a fact that the great doctrine of '*the survival of the fittest*' holds good for microbes in the soil, as for all other organised things everywhere; and that organisms which flourish in the human body, languish and cease to multiply in the soil, where the conditions are unsuited for their multiplication or even for their survival. They get overgrown by saprophytic microbes, and even if they do not die the risk of their finding their way into the ground water is practically nil, for we have seen that humus is the best of filters.

The life-history of at least one microbe, which undoubtedly flourishes in the human intestine, has been very carefully studied by many observers, and it may profitably occupy our attention for a time. This is the so-called spirillum of Asiatic cholera, the 'comma bacillus' of Koch, of which we have heard so much, and which is now generally accepted as being the *causa causans* of the disease. The subject is brought forward merely as the life-history of a microbe which undoubtedly

flourishes in the human intestine, and has not been found except in association with a deadly disease. This microbe, which has been met with exclusively in the dejecta of cholera patients, is easily cultivated on gelatine or potatoes, in neutralised meat infusion, on blood serum, and in milk, its growth being unaccompanied by any disagreeable odour. Growth ceases when the infusions become very dilute, and in water growth only takes place at the margin where there is an accumulation of nutrient material. Growth is able to take place with a very limited supply of oxygen, as is shown by its multiplication in the intestine, and it is most active when the temperature is high, viz. 30° to 40° C. Koch has made the very interesting observation that comma bacilli die very rapidly when dried. A cultivation if spread out upon glass and exposed to the ordinary temperature is dead and incapable of further multiplication in a very few hours. Hence it is inferred that no living comma bacillus can exist in dust, and that the transport of *living* comma bacilli through the air is impossible.

Another factor very unfavourable to the growth of comma bacilli is the presence of saprophytes in large quantities; under these circumstances they are overpowered, and die out. 'If the saprophytes are in excess in the first instance, or if the sum total of the conditions of life are not very favourable to the comma bacilli, the latter do not multiply at all, but the saprophytic bacteria lead rapidly to the death of the comma bacilli present, either by using up the nutrient material or by producing poisonous products' (Flügge). If, however, the bacilli be kept moist in the absence of saprophytes, they may be kept alive for months. Low temperature (freezing) does not kill them, but merely suspends their vitality; temperatures over 60° C. soon kill them.

If the bacilli find their way into pure running water, or wells of 'pure' water, it is probable that multiplication never occurs. In the case of stagnant water, however, in the bilge-water of ships, in the water in harbours, which is often extremely dirty, it is probable that the comma bacilli may retain their vitality for a much longer time; and in the case of a tank in India, 'where the small amount of water was not only employed for bathing, drinking, and cooking, but also for washing the linen and for the reception of the contents of the water-closets, Koch was able to demonstrate such a large number of comma bacilli that it seemed likely they had multiplied to a great extent in the tank, and that their presence was in all probability the source of infection of a number of cases of cholera which occurred at a later period among those persons who lived in the neighbourhood' (Flügge).

Supposing comma bacilli to exist in dejecta, what is the best way to stop their multiplication and accidental passage into drinking water? Clearly to dry them and place them with saprophytes. If they be buried in the upper layer of vegetable mould the sun will dry them; or even if it be raining the living filter will stop their passage downwards. The growth of saprophytes will kill them; and if the ground be cultivated, the comma bacilli will be destroyed and nitrified, and pass upwards into the crop, and not downwards into the wells. If, on the other hand, the dejecta be mixed with water, and be taken in an impermeable pipe through the living humus of the surface, to the dead mineral subsoil where the sun does not reach to dry them, and where saprophytes to eat them up exist not, the danger of their finding their way through interstices and crevices into drinking water appears to be very great indeed, especially

if the dirty water be in a cesspool which leaks *under pressure*, as is explained elsewhere.

That the under layers of the soil are a very inefficient barrier against filth contamination has been demonstrated in all our large towns, and especially in London. In that city the lower rooms of the houses are almost universally below the level of the street, and the house drains leave the house at the lowest point to reach the sewer at a lower level still. As underground drains, however well laid, are sure to leak in time, their contents escape; and water continually escaping at one point is sure to work a channel for itself, and take its natural course to the nearest stream or well. Still more is this sure to happen if the house drain leads to a cesspool, a contrivance which necessity invented as soon as we had water under pressure, and began to use it as our only scavenger.

In London, a city renowned for its innumerable wells, we have had to close every one of them, and as the excessive dirtiness of the air makes rain-water not available for domestic purposes, we have become absolutely dependent upon the water companies, and it is only quite recently that the public has become alive to the fact that the causes which poisoned the surface wells are equally poisoning the Thames and the Lea, and the other sources of London water. No thinking being can feel easy about the London water-supply, and it is to be hoped that some day the public mind will be roused to an appreciation of the fact that if we want pure water we must make some serious attempt not to foul our wells and streams.

One cannot but feel that in our sanitary arrangements we have not sufficiently distinguished between the living mould of the surface and the dead earth of the

subsoil. The living mould is our only efficient scavenger, which thrives and grows fat upon every kind of organic refuse; our only efficient filter, a filter which swells and offers an impassable barrier to infective particles, a filter which affords a sure protection to our surface wells. When we perforate the living humus with a pipe, and take our dirty water to the subsoil, we, as it were, prick a hole in our filter, and every chemist knows what that means.

The amount of carbonic acid in the air has been taken by some as an index of the organic impurity of the soil; but it is tolerably certain that it would be dangerous to draw any conclusions as to the wholesomeness or unwholesomeness of a soil from the estimation of carbonic acid only. Just as nitrates in water show us that nitrogenous matter has been oxidised and rendered harmless, so carbonic acid in soil air shows us that carbonaceous matter has been oxidised.

The carbonic acid, as an index of the respiration of the soil, may often be regarded as a measure of its fertility. It is always most abundant in porous soils, and may be partly due to the action of vegetable acids on previously formed carbonates.

Pettenkofer found that the ground air of Sahara was identical in composition with the atmosphere; and Dr. Hunter Stewart found far more carbonic acid in the rich humus of the grounds of the Royal Infirmary at Edinburgh than in the stiff, clayey, and comparatively unproductive soil of the grounds of Heriot's Hospital, close by. It is tolerably certain that the fertility of soils containing organic matter can, by the production of green-leaved plants, be made use of to freshen the air round our dwellings to a degree which must much more than counterbalance any theoretical fouling

of the air by the escape of carbonic acid from the soil.

We hear a good deal of the dangers of 'impurity of soil,' and it is well to bear in mind that tillage is a safer remedy than concrete.

The desert of Sahara, it must be remembered, will not support life; and notwithstanding the purity of its ground air, which might prove an attraction to some sanitarians, there are doubtless others who prefer to run their risks of longevity among the luxuriant verdure of England, a verdure which is largely due to the organic matter in the soil.

Doubtless in cities, the soil of which is permeated by a network of broken and leaking sewers, the soil gets dangerously foul, and impermeable foundations for the houses are, on theoretical grounds, most advisable. This foulness, be it remembered, is caused by unscientific methods of filth disposal, and the sealing up of the filth by concrete is no wise remedy. It is analogous to the leaden coffin, which merely prevents oxidation and purification. The more filthy the soil of a city becomes, and in proportion to the extent of surface which is hermetically sealed, so is the risk of getting dangerous emanations from vent-holes accidentally made in the impermeable cover. It must be remembered, however, that the doctrine of dangerous soil-emanations in cities is a doctrine which has much inherent probability, although the evidence drawn from practical experience is of the flimsiest. No little mischief has been done in sanitary matters by pushing theories to their apparently logical conclusions without applying the check of practical experience.

In order to keep the soil healthy, to keep up its appetite for dirt and its power of digestion, the only

thing necessary is tillage. Well-cultivated soil, which is compelled to produce good crops, has never yet been convicted of causing any danger to health.

Sanitation is purely an agricultural question, and in the country, where every cottage has, or should have, its patch of garden, there ought to be no difficulty in the daily removal of refuse from the house, and in applying it to agricultural purposes, without any risk of contaminating the water-supply. Given the patch of garden, the only thing necessary to bring about this, the only complete form of sanitation, is the will to do it—the will, that is, to do a profit to one's self, without the possibility of damaging one's neighbour. This, unfortunately, is rarely forthcoming, in spite of the Christian religion and the Education Act, and we go on, even in country places, polluting our streams and wells, with our minds agitated, as well they may be, as to when our water will become too poisonous to drink, and where we shall turn for a pure supply in the future.

Sanitation is a purely agricultural and biological question. It is not an engineering question, and it is not a chemical question, and the more of engineering and chemistry we apply to sanitation the more difficult is the purifying agriculture. This, at least, has been the practical result in this country.

The only engineering implements which the cottager with a bit of garden requires for his sanitation are a waterpot and a spade, and if his garden be an allotment away from the cottage, a wheelbarrow may become necessary. The cottager, to whom the produce of his bit of land is a matter of consequence, will endeavour to fertilise as much land as possible with the organic refuse at his disposal, and as long as this endeavour is made there need be no fear of failure, either from the agri-

cultural or sanitary point of view. When, however, an engineer, by means of water under pressure, has collected the organic refuse of a province at one spot, has diluted it a thousandfold, and endeavours to submit it to a mock purification by means of the least amount of land possible, failure is inevitable, both in the agricultural and sanitary sense. It was in 1848 that the advice to 'drain' was tendered with a light heart by the pioneers of modern sanitation, who thought it would be an easy thing to purify the sewage and make a profit from it. The Thames, the Liffey, the Clyde, the Mersey, and the Irwell are a standing testimony to the failure of these great engineering schemes, and one of the last engineering schemes put forward with regard to the sewage of London, viz. to convey it all to the Essex coast and cast it into the sea, is not only a most lame and impotent conclusion, quite unanticipated by the pioneers of '48, but it is an experiment which, like our previous experiments, may be productive of unforeseen results.

The engineer of the present day, when dealing with sewage, appears to think that one may 'as well be hung for a sheep as a lamb,' and he is ever ready to tender the advice that 'if you are going to make a mess, it is well to make a big one.' It is quite characteristic that this last scheme for dealing with the London sewage contemplated dealing not only with the material which is collected by our present system of sewers, but proposed to take that of other and adjacent systems as well.

The people of Berlin have in this respect shown themselves wiser than the people of London, because they have taken their sewage to several points instead of collecting it all at one spot.

The panacea for all sanitary ills has been and still is 'drainage,' and the only scavenger that is in favour is

water, notwithstanding the fact that sanitation by water has for its main characteristic 'incompleteness.' The work is begun and never finished. Our houses are flushed, but we pay for it by fouling every natural source of pure water, whether river or surface well. If there come an outbreak of typhoid, we, as often as not, find the 'drains' are to blame, but, as a matter of fact, we prescribe 'more drains' as the remedy.

The author has asked his friend and former pupil, Mr. F. W. Wells, M.B., to go through the official reports which have emanated from Whitehall since 1856, and make an abstract of the chief outbreaks of typhoid fever in this country which have been reported by the medical officers of the Privy Council and the Local Government Board. This Mr. Wells has done in a most painstaking and methodical manner, but the tables which he has constructed have been omitted as unsuited to the present volume. A perusal of these tables showed that there is one factor common to all these outbreaks, viz. the mixing of excremental matters with water. This mixture generally leaks to the well or rivulet or water-pipe which supplies the drinking water, which water has not unfrequently been sold under the name of milk, and the result is an outbreak of typhoid. Or the mixture putrefies in a cesspool or sewer, and the gases, finding an entrance to our houses, cause an outbreak of typhoid. There is no doubt whatever that whenever excrement is mixed with water we are in danger of typhoid. Typhoid was not recognised in this country until the water-closet became common. We, doubtless, manufactured typhoid in a retail fashion in old days, but with the invention of the water-closet we unconsciously embarked in a wholesale business.

We had not been at this work many years before we

recognised that the water-closet poisoned all sources of water. We have had to go far afield for drinking-water, and the result has been that, as we have left off consuming the springs which we have wilfully poisoned, the amount of typhoid has somewhat abated. When the more remote sources of water get poisoned in their turn—as with our increasing population, and our methods of sanitation, is inevitable—the present comparative abatement must, one would fear, cease.

The foregoing observations apply, be it observed, to cholera equally with typhoid.

It is comparatively recently that we have learnt to recognise the dangers which result from the putrefaction of a mixture of excrement and water in a sewer or cess-pool. The ingenuity of sanitary engineers has been exercised to save us from these dangers, and they have given us what they are pleased to call self-cleansing sewers, innumerable forms of trap, endless methods of ventilation, and disconnexion on scientific lines, until the medical officer of health is expected to have at his fingers' ends all the knowledge of a patent agent and a plumber's foreman. If apparatus never wore out, if ventilators never got stopped up, if traps never got un-sealed by leakage, evaporation, or other cause, one might feel secure against the enemy which is ever at our gates, provided the study of Bacteriology did not lead us to recognise that a few feet of filthy pipe may be as dangerous as a mile, and that a trap may possibly serve, especially in hot weather and when the family is away, as a most efficient 'cultivating chamber.'

It is commonly urged by those who defend our present methods of sanitation that, as we must of necessity provide some channel for the escape of slops from our houses, it is false economy not to make these channels

carry everything; or, in other words, that, as sewers are a necessity, there is no harm in making them a bigger nuisance than they necessarily must be. It is difficult for the author to follow this argument, and he would submit some reasons why every effort should be made to keep excremental matters out of the sewers.

1. Excrement is the only ingredient of sewage against which dangerous infective properties have been proved again and again. It is the ingredient which, when mixed with water, finds its way to our drinking water and causes typhoid and cholera. Sewage without excremental matters is neither offensive nor unwholesome unless it be allowed to putrefy. It stands in the position of a 'suspect' rather than that of an habitual criminal against whom no end of previous convictions have been proved.

2. If excremental matters were stopped out of our house drains we could, in country places, often have recourse to the old practice of allowing our household slops to run in open gutters, concerning the ventilation of which there could be no doubt, and the gutters might be subjected to the wholesome discipline of a broom and the purifying influences of sunlight and drying winds.

3. If excremental matters be stopped out of the house drains, the total volume of sewage to be dealt with would be diminished by at least one-fifth, and this surely would be a great gain. We should deprive the sewage of just those ingredients which give most trouble to the sewage farmer by clogging the pores of the ground, and we should leave the sewage very 'thin' and admirably suited for downward filtration. It seems to be an acknowledged fact that, for the application of sewage to the land, the more watery it is and the more completely

solid matters are strained out of it, the simpler and more satisfactory the processes become.

4. Another class of objections which has been made to the exclusion of solid excrement from house drains has reference to the so-called 'manurial value' of sewage and its constituents—that excreta without the total urine are of low manurial value, and that the stopping of excreta out of the sewers lowers the manurial value of the sewage. 'Manurial value' is a term used by chemists to express the amount of nitrogen that may be present. Now one does not doubt the ability of chemists to make a quantitative estimation of nitrogen, nor their power of informing farmers of the extent to which they may or may not have been cheated when they purchase artificial manures, but it is evident that the real practical manurial value depends, not only upon the amount of plant-food present, but also upon whether the plant-food is present in a form in which it can be digested and exhaustively utilised by the plant. For the latter information, which is of the highest importance, the author would sooner apply to a practical farmer or gardener than a chemist.

A chemist, for instance, who had regard to his analyses and nothing else, might tell us that nutshells had a certain dietetic value; but ordinary men and monkeys know better than that.

He might tell us that gin was richer in certain dietetic ingredients than ginger-beer, but we know that ginger-beer is the better article of diet.

Again, guano has a far higher manurial value than 'rich garden mould'—such as is got by mixing earth with organic refuse; but if we do not dilute our guano to the same level, so to say, as our rich garden mould, we may kill our plants. To declare that rich garden

mould is of low manurial value is absurd, because we know that in it plants of all kinds reach the highest development which is attainable. Farmers and market gardeners will tell you that artificial manures have 'got no bottom in them,' that their use is, so to say, a speculation; and if climatic conditions are unfavourable when the artificials are applied, the money spent on them is lost for ever. With organic refuse, however, the case is entirely different, and the effect of the application of organic matter, especially of human origin, to the soil is plainly discernible for three or four years. Solid organic matter is little liable to be washed away, it nitrifies slowly, and doles out the nitrates to the roots of the plants in proportion as they are needed.

It is necessary to say, emphatically, that the manurial value of human excrement is enormous, and that it produces all kinds of fruits, flowers, and vegetables in the highest perfection. Speaking from a practical experience of twenty years, my belief is that soil cannot be made more fertile than by mixing it with solid excremental matter.

It is quite true, no doubt, that the manurial value of urine is very great, but being fluid it is not so easily retained at the spot where the agriculturist wants it; and we know that when fresh and undiluted it is very dangerous to herbage. The fact is that plants absorb their nutriment from very dilute solutions; and it has been found that a fluid containing about 0·2 per cent. of solids is the *optimum* for plant culture. Ordinary urine, therefore, which contains 4 per cent. is twenty times too strong; but if it be applied to the soil in its state of optimum dilution, much of the liquid will necessarily soak out of the reach of the roots.

Manurial value is a practical matter rather than a

chemical problem, and there is no doubt whatever that those who assert the manurial value of earth-closet manure to be low are making a very serious practical mistake; and there is no doubt that arguments based on the theoretical manurial value of sewage as a whole, or of its several ingredients, are worthless in helping us to decide whether it is advisable or otherwise to keep solid matters out of the drains.

What use is there in discussing the 'manurial value' of sewage in the face of the deliberate declaration of that eminent agriculturist, Mr. Clare Sewell Read, made in the 'Journal of the Royal Agricultural Society'? 'Sewage,' says Mr. Read, 'has come to be regarded by all sensible people simply as a nuisance to be got rid of.' And he goes on to state that, owing to the unmanageable quantities of water which have to be dealt with, sewage is ruinous to all grain crops and all other farm crops except rye-grass.

The composition of sewage as it flows from towns is so doubtful, and must be so variable, that no sensible man would let it run over his farm. Chemicals and antiseptics are very abundant at the present day, and they are very largely used to lessen the dangers which are inherent in our present system of sanitation. Antiseptics, however, which stop the growth of putrefactive microbes, also check the growth of nitrifying organisms, and are deadly poison to plants. All town sewage is liable to contain dangerous chemicals which must render the 'manurial value' a very minus quantity, the presence of nitrogen notwithstanding.

As it is idle to discuss the theoretical manurial value of a practical nuisance which no sane farmer would take as a gift, it is imperative for us to discover means, if possible, by which those ingredients of sewage which

have great enriching power for the soil may be saved for the benefit of the cultivator and consumer.

From every point of view—scientific, sanitary, moral, economic—the author feels strongly that dwellers in the country should take warning by the towns. They should revert to the cleanly and decent habits of our forefathers, and keep the sanitary offices away from the main structure of the house, and not, as is the dangerous custom of the present day, bring them almost into the bedrooms. They should keep solid matters out of the house drains, and see that they are decently buried in the living earth every day, and they should replace the drains by gutters and filter all the household slops by applying them to the *top* of a different piece of cultivated ground every day. Whether an ordinary watering-pot, or a tank upon wheels drawn by a horse, is necessary for accomplishing this latter object will depend upon the size of the establishment; but only those who have systematically pursued this plan can know the vigour which is imparted to hedgerows, shrubberies, fruit trees, or forest trees by a tolerably frequent dose of household slops. There is no difficulty in doing this, provided the will be present—the will, that is, to combine your duty towards your neighbour with an act which is profitable to yourself.

Finally, to dwellers in the country, whether squires who are the owners of broad acres, or occupants of modest villas with a garden, or, still more, to cottagers with an allotment where it ought to be, round the cottage, the following principles of action are recommended:—

1. That sewage being a nuisance, although a necessity, it is to our interest not unnecessarily to increase its quantity or its offensiveness.

2. That excrement should be kept out of the drains, for by doing this the putrefaction of the solid is prevented and the purification of the liquid by filtration through the earth is effected with ease which is proportionate to the thinness of the fluid.

3. That all solid matter should be removed every day from the immediate neighbourhood of the house and buried in the top layer of *cultivated* ground. Household slops should be poured on to the surface of the garden, and the mistake of attempting what is known as 'subsoil irrigation' must not be made.

If these directions be followed, it is evident that by no possibility can one be troubled by sewer gas, and it would probably be no longer dangerous to drink from surface wells.

The practical experience of the author in dealing with sewage in the manner which is here advocated will be dealt with at some length in a subsequent chapter.

Although the author is addressing himself to dwellers in the country, he would like to say to town-dwellers that complete sanitation is impossible, unless cultivated land be brought into tolerably close relationship with the dwelling. At present our sanitary arrangements are magnificently begun, and seldom completed, and while we almost uniformly leave a most dangerous loose end to our sanitary measures, we shut our eyes to it, and blow the trumpet of self-satisfaction as if the sanitary millennium had begun. The Allotment Act, as affording an outlet for organic refuse, ought not to be without its effect upon sanitation, and it is to be hoped that the masses will some day wake up to the great importance, from the moral and sanitary standpoint, of providing every dwelling with an adequate curtilage. As things go at present, there is very little doubt that the agricultural

labourer with his cottage and garden and 12*s.* a week is infinitely better off than the town artisan on 25*s.*, who pays dearly for pigging it in overcrowded rooms, in which a cleanly and decent existence is impossible.

In a recent volume of the 'Transactions of the Sanitary Institute' is a very interesting paper by Dr. Sykes, who quotes Dr. Corfield, who, in his turn, is quoting Sir Henry Acland, to the effect that the disappearance of the great cities of antiquity was due to pestilence rather than war. We must all admit the possibility of such an assumption, and certainly no one can ponder upon the disappearance of Egyptian, Babylonian, Assyrian, Greek, and Roman civilisation without speculating upon the cause, and without applying the lesson to ourselves, and asking, how much longer is our British civilisation to continue?

Nationalities seem as mortal as the individuals which compose them.

If great nations are destroyed by neglect of sanitary laws, and if prolonged national life is indicative of sound sanitary measures, there is at least one race upon the globe which is worthy of profound study by all who concern themselves with public health. This race is the Chinese, who have seen all the nations of antiquity in and out, who were probably a great people in the days of Moses and before, and whose thrifty myriads are even now successfully contending with the British race in America and Australasia. The Chinese, as is well known, have had to contend with national calamities of a most stupendous kind. In our own days we hear of floods and famines which claim their millions of victims, and yet the race continues to increase in such a way, and to overflow its natural boundaries to such an extent, that it is certain, even without the exact returns of a Registrar-

General, that the birth-rate must very considerably exceed the death-rate, and must have done so in an average way during the three or four thousand years that the Chinese nation has existed.

There is little doubt that, unless we mend our ways, the Chinese will see us out, as they have seen the other great nations of the world out, and the reason for this belief is obvious. The Chinese are the most thrifty nation in the world. In China nothing is wasted, and all organic refuse is ultimately returned to the soil. Even the dead bodies of the Chinese who die abroad are returned to China for burial. Agriculture is, in China, a sacred duty, and the Chinese have got a firm grasp of the elementary principle that, if the fertility of the earth is to be maintained, we must constantly replenish it. The nineteenth volume of the Health Exhibition literature contains a most interesting series of papers on China, by Surgeon-General Gordon, Mr. Hippisley, and Dr. Dudgeon, of Pekin. The papers by Dr. Dudgeon are especially worthy of study, for many years of residence among the Chinese have impressed him with the fact that we have much to learn from them.

The question of our duty to the soil is fundamental in sanitary matters. If we starve the soil and turn our fertilising materials into the sea, we may rid ourselves (though this is doubtful) of filth diseases for a time; but it is by no means doubtful that we shall ultimately replace filth diseases by those diseases that are bred of starvation. How soon this will happen no one can say, but that it will happen eventually seems to me as certain as is the axiom, 'Ex nihilo nihil fit.' Do not let us commit the great blunder, when dealing with this national question, of forgetting that the life of a nation ought to be measured by centuries; do not let us make a suicidal

use of a paltry fifty years' statistics, and because the figures of the last decennium happen to be favourable, conclude therefrom that all our sanitary principles are right.

Perhaps some one will say, 'How ridiculous to hold up the Chinese as an example! The Chinese masses are acknowledged to be exceptionally filthy in their customs and habits.' This, perhaps, is true, but I am sure that the reader will not make the error of confounding principles with details. The Chinese principle of returning all organic refuse to the soil is, there can be no doubt, absolutely sound. The Chinese details may be filthy and susceptible of improvement. In this country the details of our domestic sanitation are refined, elegant, and ingenious. It is the principle subserved by these details which is absolutely rotten. The main problem of sanitation is to cleanse the dwelling *day by day*, without fostering starvation. This can only be done by returning all organic refuse to the soil, and the perfecting of the details, by which this duty is to be done, is the most important work of the modern sanitarian.

This question is a national one, and concerns us all. Every country squire ought, in these matters, to set a good example to his tenants. If he does not set the example of increasing the fertility of the soil by the daily addition to it of all the organic refuse of his country mansion, he cannot command our sympathy when he goes without his full rent. If a landowner embarks on a great building scheme, he ought to keep the sanitation in his own hands. If a well-known landowner had done this—if he had preserved his autonomy on his own estate, and if he had, by a rational use of the railway, transferred the daily scavengings of his valuable City

estate to his broad acres in the country, perhaps his right-of-way on his London estate would not have been contested, and perhaps he would not have been obliged to remit 25 per cent. of his agricultural rental. As it is, he allowed the vestry to do his sanitation for him, and by so doing lost his autonomy. Who can see how far the process of confiscation which has set in will ultimately reach?

This question has an immediate personal interest for all who derive their income from the soil. The clergy would do well to enforce by example as well as by precept the old injunction, to 'replenish the earth and subdue it.' If they do not, they must expect to go without their tithes. Improvement in this direction is only to be attained by rousing the public conscience. So soon as the majority of individuals are impressed with the fact that it is wicked to foul our streams and starve our soil, and that our individual responsibility does not end, even though the fouling and starving be done by a 'Board,' so much the better will it be for the public health and national wealth. Parliament has compelled us to hand over our responsibilities to public authorities, with the consequence that the individual has lost his liberty and independence, and is drifting into a condition of sanitary imbecility. Let us not forget that the present state of our rivers is the direct result of Acts of Parliament. Let us not forget that Parliament, which wasted its time and our money in passing that most inoperative of all Acts, the 'Rivers Pollution Act,' scavenges its own palace direct into the Thames; as though Imperial Parliament could hand over its responsibilities to a Local Board! It is hardly credible that such a condition of things could exist outside the libretto of a comic opera.

A respect for the purity of water should be enforced in our Board schools and churches; and that powerful party in the State—the Temperance party—would do well to devote some of its energies towards ensuring that the beverage which it champions should be in all places a safe one to drink. As it is, one has only to walk about the country to see that our streams and rivulets are universally regarded as receptacles for rubbish and impurities of every kind.

This question is a national question of the first importance. A nation that fouls its streams and starves its soil is in danger of poisoning and inanition. A nation which imports a great part of its food and a great part of its manure, and systematically and by Act of Parliament throws all its organic refuse into the sea, is living on its capital. Our capital just now is undoubtedly considerable, but we are in a fair way to run through it; and when we have done so who can forecast the future?

In connexion with the power of 'the Living Earth' to deal with organic fluids, a very interesting series of experiments has been made at the author's suggestion by Dr. Wells on the filtration of urine through earth, and what follows is an abstract of Dr. Wells's report on the matter.

A conical metal vessel (fig. 7), 2 ft. 6 in. in length, 1 ft. in diameter at the base, and perforated at the apex, was filled with dry earth. To this was added day by day an amount of urine averaging about half a pint. In the first three experiments, made between July 1890 and February 1891, fifty-nine separate analyses were made of the urine committed to the filters, involving the estimation of urea, sodium chloride, organic and mineral residues, and in subsequent experiments the averages

of these analyses have been regarded as sufficiently accurate for purposes of comparison between urine and filtrate.

In the first experiment the following results were obtained: 200 oz. of urine were added to the filter, of

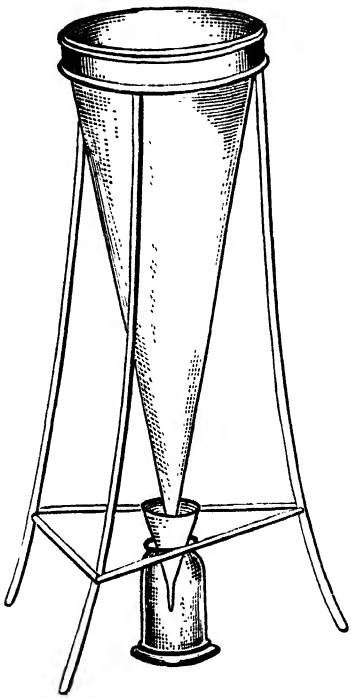


FIG. 7.

which 73 oz. appeared as filtrate, the remaining 127 oz. representing what was lost by evaporation *plus* what remained in the filter. The average specific gravity of the urine was 1021·4, that of the filtrate 1011. The

total solids of the urine averaged 4·44 per cent., of which 3·45 per cent. were organic and 0·99 per cent. inorganic, while the total solids of the filtrate averaged 1·78 per cent., of which 1·069 was organic and 0·710 inorganic. The chlorides in the urine averaged 1·09 per cent., and in the filtrate 0·67 per cent. The total solids of the urine added would be nearly 9 oz., and the total solids of the filtrate obtained about 1⅓ oz., so that 7⅔ oz. of solid residue were left in the filter. The appropriation of these 7⅔ oz. of residue by the filter will be again referred to.

The surface of the filter, when the nose was closely applied, smelt distinctly ammoniacal; but the filtrate, although of deep colour, could be evaporated to dryness without offensive smell.

None of the filtrates, after standing for weeks exposed to the air, underwent any putrefactive change, nor did any of them give off offensive smell when evaporated to dryness. In colour they have varied from an almost colourless filtrate to a yellow or deep reddish-brown. In order to ascertain whether the colouring matter was of a urinary nature, part of the filtrate obtained from the first experiment was sent to Dr. MacMunn, of Wolverhampton, who kindly examined it, and has furnished the following report of his examination :—

'A total absence of normal urinary pigment and chromogen—that is, no urobilin, no indican, &c. The colour is probably due to the presence of some humus substance derived from the earth through which it has been filtered.'

Other experiments were made with mould that had been previously used, an interval of five months having elapsed, during which the mould had remained intact.

One hundred and nine ounces of urine were added, of average specific gravity 1024·3, with the following percentage analysis :—Urea, 2·6; chlorides, 1·2; residue, 5·48, being organic 4·12, mineral 1·35. Twenty-four ounces of filtrate were obtained, of a uniform specific gravity 1035, with urea 0·2 gram per cent. Thus the power of the filter to change the urea was as great as ever. Of chlorides there were 1·5 per cent., and residue 6·07 per cent., being organic 3·37 and mineral 2·70 per cent.—that is, the mineral residue of the filtrate was exactly double the amount of that in the urine; and it was evidently not due to chlorides, the respective average percentages being—urine, 1·2; filtrate, 1·5. It seems probable that the 7½ oz. of residue left in the filtrate during the five months' interval had to a great extent nitrified and become soluble. Given an ammoniacal solution and garden soil, we have the readiest means of inducing nitrification. And, testing the filtrate qualitatively with ferrous sulphate and sulphuric acid, there was abundant evidence of the presence of nitrates.

Allusion may also be made to an experiment intended to ascertain what difference in results might be obtained from a water and a urine filtration through mould. Two glass funnels (fig. 8) were employed, each of about four pints' capacity, and were filled with mould. To one was added during a period of twenty days, in regular amounts, 1½ oz. of tap water, and to the other an equal amount of urine. Rye-grass seed was, moreover, sown on each filter surface. The water filter produced 7½ oz. filtrate, and developed an excellent crop of rye-grass; the urine filter produced 5½ oz. of filtrate and no grass. The daily addition of *water* was followed, after the filtrate had once commenced to appear, by an almost *immediate* dropping of filtrate; *the urine tarried*

much longer in the mould. That no grass would grow on the mould to which urine was being daily added was to be expected, ordinary urine being about twenty times too strong for plant culture. The filtrate obtained from the urine filter was odourless, clear, of pale yellow colour, specific gravity 1006, containing about 0·5 per cent. of urea (? or other nitrogenous bodies), and

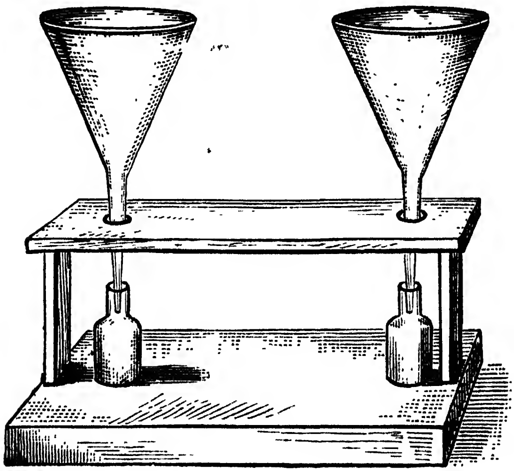


Fig. 8.

yielding no offensive smell on evaporation to dryness. The water filtrate was of faint yellow colour, and of specific gravity 1000. Finally, a few experiments were made as to the fertility of the mould from the filters. In May 1891 a mixture of mould that had been used for filtration experiments (one-half of which had, moreover, been sterilised by heat) was sent to Andover, and there twenty cuttings of common yellow calceolaria were

placed in pots: ten in garden soil from the garden at Andover; ten in the London mould. The pots were placed in the open. In the ten pots of Andover soil the calceolarias had done fairly well, and each pot had grown an abundant crop of weeds. In the ten pots of London earth the calceolarias were all dead, and there was not a single weed visible. They were the embodiment of absolute barrenness. Corresponding portions of mould were used for urine filtration, and yielded a filtrate of specific gravity 1041, with a large percentage of urea. In no case has grass grown on the surface of a filter in use; but, on mould that has remained for several months exposed to the light and air in the garden after usage in the filters, grass has been cultivated most readily, yielding a better crop than that produced by unused mould.

Although these experiments are manifestly incomplete in some particulars, they show very conclusively how great is the power of the earth to deal not only with organic solids but also with organic liquids, such as urine. The author is not aware that any experiments similar to the above have been published, and attention may be directed to four facts: 1. That the filtrate obtained from the filtration of urine through fresh earth was always a much thinner fluid than the urine added, the bulk of the solids dissolved in the urine having been left behind in the earth. 2. The filtrate showed no tendency to putrefy, and certainly contained no putrefactive organisms, for it was shown to be incapable of starting putrefactive changes in urine which had been previously sterilised. 3. The filtrate could in all cases be evaporated to dryness without giving off offensive odours, offering in this particular a great contrast to pure urine, which invariably emits most disgusting odours

when evaporated to dryness. 4. The organic residue left in the earth apparently underwent nitrification in course of time, but it was noteworthy that earth which had been used for the filtration of relatively a very large amount of urine was in all cases barren until it had been exposed to air and rain. After such exposure, however, its fertility appeared to be of a high order. The practical importance of this matter to sanitarians and agriculturists is very great. In London, with its 4,000,000 inhabitants and endless throng of visitors, it is probable that 10,000,000 pints of urine are daily run to waste, and it must be remembered that these 10,000,000 pints contain about 200 tons weight of most valuable manure.

It is interesting to note that humus from different localities seems to differ in its power of dealing with urine. The humus from Gower Street (which is largely adulterated with London 'blacks') seems to be undoubtedly inferior to that of Brondesbury. The best of the Brondesbury results, in which the filtrate had a specific gravity of only 1003, and contained no appreciable amount of organic matter, was certainly very remarkable.

Since the foregoing experiments were made, the effect of filtering urine through a variety of materials has been tried. The filter used was a metal cone 1 ft. in diameter at its base, and 2 ft. 6 in. in length.

On July 24, 1893, this filter was filled with pieces of old cement stucco which had burst away from the wall of a house during the frosts of the previous winter. Urine was added very intermittingly and irregularly up to October 9, 1893, when 246 oz. of urine had been added. A filtrate began to appear on July 31, when 101 oz. had been added. The total amount of filtrate was 190 oz. The large amount of filtrate makes one think that the

filter was not adequately protected from rain. This filtrate varied in colour from a very pale yellow to a darkish yellow, and its specific gravity varied from 1003 to 1005. At first it was neutral, but finally was faintly ammoniacal. The contents of the filter when turned out smelt strongly ammoniacal, but not in the least offensive. Part of the filtrate was put in a big white glass bottle and was placed in an exposed tool-shed. It had no urinous or offensive smell, and remained perfectly sweet all the autumn. During the winter it froze solid, and as the bottle was burst it had to be decanted (after thawing) into another bottle. After thawing, a white mineral precipitate fell, and then the bottle of fluid (which was exposed to the light) became slightly permeated by a green algoid growth, which flourished and ultimately subsided to the bottom.

The fluid on August 1, 1894, was indistinguishable to the eye or nose from an ordinary sample of water, and had a specific gravity of 1001. The above experiment is of interest because the filtering material was, except for accidental impurities, inorganic, and the ultimate result was a fluid indistinguishable from water. The effect of frost was also most interesting, and seems to open up a field for study.

Urine filtered through dead leaves and miscellaneous sweepings gave, as a filtrate, a highly coloured thick fluid of low specific gravity (1005), which remained muddy and opaque until after a severe frost, when it separated into two layers, the top clear and transparent, the bottom thick.

A considerable number of experiments has been made with sawdust, which may now be summarised. On December 29, 1893, 6 lb. weight of sawdust, with a tuft of hay for a plug, was placed in the conical metal filter.

Between that date and February 6, 217 oz. of urine had been added to the filter, and 32 oz. of filtrate had been obtained. The sawdust retained 185 oz. or more than $11\frac{1}{2}$ lb. weight of urine. The sawdust in the filter was now turned out and was found to weigh 10 lb., and this, after partial drying by exposure in a shed, was placed again in the filter on February 19, between which date and February 27, $61\frac{1}{2}$ oz. of urine was added and 5 oz. of filtrate obtained. Thus, as a total result of this first experiment, 6 lb. weight of sawdust retained (or evaporated) $241\frac{1}{2}$ oz. (say 15 lb. weight) of urine and gave 37 oz. of filtrate.

In a second experiment the metal filter filled with 6 lb. of fresh sawdust had added to it, between February 6 and 18, 187 oz. of urine, and yielded 17 oz. of filtrate. The sawdust in the filter (nearly saturated) was found to weigh 16 lb., and was placed in a loose bag made of cheese-cloth and hung up in an open shed. On April 5 this weighed $9\frac{1}{2}$ lb., having lost by evaporation $6\frac{1}{2}$ lb.

This sawdust (partially dried) was replaced in the filter on April 5, and by April 21, 247 oz. of urine had been added and 72 oz. of filtrate had been obtained.

The sawdust was found to weigh 18 lb., and was hung up to dry in cheese-cloth on April 21. On May 21 it was found to weigh 9 lb., having lost 9 lb. by evaporation, and it was placed a third time in the filter on May 21, between which date and July 1, 373 oz. of urine had been added and 157 oz. of filtrate obtained.

The filter was left exposed to the sun, and twenty-three days after the last addition of urine had been made, the contents, which were found to weigh $13\frac{3}{4}$ lb., were hung up to dry in cheese-cloth.

In this second experiment, which extended from February 6 to July 1, there had been added to the same

6 lb. of sawdust 807 oz., or more than 50 lb., of urine, of which 246 oz., or more than 15 lb., had been yielded as filtrate, while 561 oz., or more than 35 lb., had been absorbed or evaporated.

In order to increase the evaporating surface of the filter, the iron vessel was replaced by a conical flannel bag which gave the maximum evaporating surface obtainable. This was placed in my room at University College on May 9, 1894, and was filled with 6 lb. weight of sawdust.

Between May 9 and July 26, 626 oz., 39 lb. weight, of urine had been added, while 54 oz. (less than 3½ lb.) of filtrate had appeared. The sawdust in this porous filter had thus absorbed, or had caused to disappear by evaporation, about six times its own weight of urine.

The amount of filtrate obtained necessarily depended on a variety of circumstances, the chief of which would appear to be (*a*) the amount and frequency of the additions of urine; (*b*) the temperature of the air surrounding the filter.

In the above experiment the first filtrate (19 oz.) appeared on June 12, when 320 oz. of urine had been added, and between that date and June 26 an additional 35 oz. were obtained (446 oz. of urine having been added). Between June 26 and July 26 no further filtrate was obtained, notwithstanding the addition of 180 oz. of urine.

These experiments with sawdust, extending from December to July, and carried on in all kinds of weather, and indoors as well as out of doors, have *in no instance* given rise to any offensive smell. If the surface of a filter which has been some time in use be stirred and the nose almost buried in it, a strong smell of ammonia is perceived, but it is the smell of pure ammonia with-

out foulness. The filter which I kept in my room at the College for some time never made one aware of its presence by any odour.

The filtrate obtained from these experiments with sawdust was peculiar, and differed markedly from the filtrates obtained with earth or stucco. While the latter were always of lower specific gravity than the urine employed, and were relatively thinner, poorer liquids, the filtrates obtained from sawdust were always of higher specific gravity, and varied from 1085 as a maximum to 1018 as a minimum. These filtrates were thick and opaque, not cleared by filtration through bibulous paper, usually alkaline in reaction (from ammonia), dark-coloured, frothing readily like porter, and smelling of sawdust, with a suggestion of resin and turpentine. On one occasion, when a flannel filter was used, the filtrate dropping from the tip was faintly acid, notwithstanding that the mouth of the filter was strongly ammoniacal. A sample of this filtrate, obtained from a flannel filter, had at first an odour decidedly sweet and aromatic, but being stored in a Winchester quart stoppered bottle, it first became pungent, and then gave off a perceptible amount of ammonium sulphide.

It may be added that the mixtures of sawdust and urine have, so far, shown no tendency to heat. So soon as ammonia begins to form, the temperature of my filters, whether of metal or flannel. has always been *lower* than the temperature of the air. What would happen if the bulk were greater, and the saturation pushed further, is a matter for speculation.

Although it is undoubted that urine has a very high manurial value, its utilisation for agricultural purposes presents practical difficulties. If used pure we know that its immediate effect is deadly, and if diluted to a

proper strength we are inconvenienced by excess of water. Dilution with water to any extent is incapable of checking the foul decomposition of urine, as many public urinals abundantly testify.

The urine of animals is preserved for agricultural purposes by mixing it with absorbent materials, the chief of which is straw, and this straw manure, when placed on the surface of the ground, gradually nitrifies, and continues to afford manurial matter to the soil for many months in succession. The offensiveness of urine depends upon the treatment it receives. Thousands of tons of urine are spilt annually in the London streets, and yet no serious offence arises because the streets are absorbent, and there is free exposure to the air. If urine be mixed with soapy water, and be allowed to stagnate either in the trap of a sink or in an underground cesspool, the smell becomes abominable.

'Dry' urinals, in which the urine is taken up by some absorbent material, seem worthy of a trial.

The following is the result of an analysis made for me by Dr. Kenwood in the Hygienic Laboratory at University College:—

July 25, 1895.

Parts per 1,000

Reaction	S.G.	Solids	Urea	SO_3	P_2O_5	Cl
Fresh urine (faintly acid) . . .	1·020	44·20	23·8	1·38	2·39	4·08
Urine after filtration through sawdust (alkaline) . .	1·034	127·9	Nil (all reduced)	8·30	13·41	38·00

'*Physical Characters.*—Urine, pale yellow, clear, with a small opaque zone from mucus, normal urine odour.

'*Sawdust Filtrate.*—Dark mahogany-brown colour —markedly opaque and somewhat turbid. A peculiar woody (resinous) odour, faintly ammoniacal.

'The "two ammonias" cannot be estimated by Wanklyn's process in the fresh urine, where there is so much urea, but in the filtrate they amount to—

$$\left.\begin{array}{ll}0{\cdot}032 & \text{free and saline} \\ 0{\cdot}0016 & \text{organic}\end{array}\right\} \text{per } 1{,}000.$$

I have kept two test-tubes half filled with urine and filtrate, tightly corked, in the warm cupboard of the laboratory for the past three weeks; the sample of fresh urine has become offensive, but that of the filtered urine is perfectly sweet, and rather pleasant to smell.'

As far as my experiments have as yet gone, I have not discovered the limit of sawdust for dealing satisfactorily with urine. Thus in 1894 I filtered during May, June, and July 39 lbs. weight of urine through 6 lbs. of sawdust in a flannel bag, and neither filtrate nor sawdust was in the least offensive. In the same months in 1895 I passed an additional 41 lbs. weight of urine through the same sawdust in the same bag, and practically with the same result. In 1896 I added over 30 lbs. weight of urine to the same sawdust, but as the flannel bag had become too rotten to hold together, I was obliged to have recourse to the metal filter-vessel. The early filtrate obtained in 1896 had a specific gravity of 1·061, but, like its predecessors, could be evaporated to dryness without offence, and the sawdust was not in the least malodorous, although it was distinctly (as it always has been in these experiments) ammoniacal.

One of the most interesting experiments was that in which the filtering material consisted of crumpled paper in a flannel bag. The paper used is such as is familiar

to every one, and was derived from old Bradshaw's Guides, the leaves of which were torn up and crumpled up in the hand before being put into the bag. This paper, like most paper used for printing, is sized and not very absorbent. At the end of a week a considerable quantity of filtrate had been obtained, and both filter and filtrate became excessively foul and malodorous, so that it was unpleasantly obtrusive, even when one stood several yards from it. The foul filtrate was returned to the filter, and no fresh urine was added for a time. This was done on October 15, and on October 21 all had become sweet, and four ounces of a perfectly sweet and *faintly acid* filtrate were obtained! The filter never became foul after this date. Between October 21 and November 25, 1894, 434 ounces of urine were added, and 54¼ ounces of filtrate were obtained. Between November 25, 1894, and January 6, 1895, the filter rested; then between January 6 and March 31 urine was added only occasionally, so that the total only amounted to 560 ounces (35 lbs. weight). Three and a half pounds weight of filtrate were obtained. The filtrate was more ammoniacal than that obtained from sawdust, earth, or peat, but it never has shown any tendency to putrefy. The paper became blackish, and was riddled with fungi, and ultimately was scarcely distinguishable from garden mould.

Thus I have shown that these absorbent materials exercise a strangely purifying power upon urine, and its behaviour with these bodies is very different to what is observed when urine is mixed with water.

These filtration experiments are of great interest, and give the clue to the *modus operandi* of porous materials, including the earth.

Urine contains about 4 per cent. of solids, of which

more than half consists of 'urea.' In the presence of certain micro-organisms, which appear to be ubiquitous, the urea is converted into ammonium carbonate, and the alkalinity of the urine thus brought about causes the precipitation of the phosphates. In this way the salts of greatest manurial value are retained upon the filters, and the filtrate is always a much thinner liquid than the urine from which it is derived.

It is to be observed that the filtrate has no tendency to putrefy, and this holds good in those cases where the same filtering material is used again and again. It must be noted that the filter was never saturated and that there was always an interval of some hours at least between the additions of the urine.

The conversion of the urea into ammonium carbonate, and the consequent precipitation of the phosphates, is due to micro-organisms which undergo an increase, and this increase in the micro-organisms ensures that with each addition of urine the change is more easy and more sure. The change is of the nature of a fermentation.

If urine be placed continuously on the same spot of earth, the earth becomes sterile, because the excess of ammonia 'burns' the herbage, and it is not until oxidation and 'nitrification' take place and the excess of salts and soluble nitrates are washed out that the fertility returns.

This strongly ammoniacal earth resembles guano, and must be used with as much care.

The putrescible and soluble ingredients of such a fluid as urine are removed when the fluid is thrown upon the earth and retained for future use in the upper layers of the soil.

The process of oxidation which subsequently takes place is greatly quickened by tillage, and if the earth be

planted at the opportune moment the husbandman gets the full advantage of the manure.

In the same way solid organic manures which are placed upon or just below the surface cannot be washed through to the subsoil until oxidation has taken place. Winter rains which make the ground sticky merely lead to the retention of the animal manures in the upper layers of the soil, where they get permeated with mould fungi. The mycelium of these fungi, often brilliantly coloured, orange, red, black, grow with a rapidity proportioned to the suitability of the weather, and ultimately bring about the complete disintegration and oxidation of the animal manure, and the soluble salts (largely nitrates) are dissolved and absorbed by the roots of the plants.

The behaviour of organic fluids and animal manures when placed upon the soil are fundamental in all questions of agriculture and sanitation. Surely we ought to utilise the nitrates and sulphates and phosphates and chlorides, together with the alkaline and earthy bases which are contained in natural manures, before we have recourse to artificial ones.

The above experiments lead to the conclusion that the 'dung-heap' is a mass of ferment which 'leavens' putrescible fluids strewn upon it and leads to their purification; mud and dirt exercise a similar action on the dirty fluids which soak through them.

The Circulation of Organic Matter

There is still another point of view from which we may regard the relationship of effete organic matter to the soil, *i.e.* that is the point of view that the 'circulation of organic matter' is an inevitable law of nature, which we may turn either to our profit or our loss.

The remarks which follow formed part of a 'Discourse' delivered at the Royal Institution on Friday, April 24, 1896.

It is quite impossible to define 'organic matter,' or to indicate the line, if there be any, between organic and inorganic.

Organic matter is the material of which living things are made. When a chemist analyses anything which is the product of life, whether vegetable or animal, he often speaks of his incombustible residue or ash as 'inorganic matter,' but this is clearly an arbitrary use of the term, for this incombustible residue has formed an indispensable part of one living thing, and may in due time be incorporated with other living things as something which they cannot do without.

It may well be that everything of which we have knowledge (even including the igneous rocks) has at one time or another formed part of a living organism, and it is certain that a large proportion of the commoner chemical elements may form a part, more or less indispensable, of the bodies and framework of plants or animals.

Oxygen, hydrogen, nitrogen, carbon, chlorine, sulphur, phosphorus, iron, sodium, potassium, and calcium seem to be indispensable to almost every living thing. Many more of the elements are constantly found in some organisms, while others, such as lead, mercury, silver, &c., may be temporarily incorporated with living bodies.

We shall deal mainly with those elements which are pre-eminently mobile, which are constantly changing and exchanging, combining and separating, and which are readily combustible. For practical purposes one might, indeed, use the terms 'organic' and 'combustible' to signify the same thing.

With regard to solid matter, the power of readily

circulating implies a readiness of combustibility, but it must be remembered that there is no hard line between combustible and incombustible. This is a matter of temperature, and many things which are incombustible here are said to be blazing in the sun.

The combustion of organic matter may take place slowly, or with moderate rapidity, or with explosive violence.

When we burn coal, which is a vegetable product, we find that the carbon and hydrogen escape as carbonic acid and water, accompanied by nitrogen, sulphuric acid, and volatile hydrocarbons. The residue consists mainly of silica and alumina, which are removed from the furnace in the form of clinker and ash. The water ultimately returns to the earth in the form of rain or dew; the carbonic acid is ultimately absorbed by green plants, and, by stimulating the growth of these, helps to furnish us with more combustible material; while the residue is almost a waste product. Thus in this example we find that the carbon and watery vapour readily 'circulate,' while the residue can only do so after a long interval of time, and is practically lost. The volatile hydrocarbons and sulphuric acid, being poisonous to herbage, are a source of practical loss rather than gain.

Let us take next the case of an animal, which is really a living furnace, browsing in a field; as it browses we may often see the breath, which is the smoke of this furnace, laden with carbonic acid and water, escaping from its mouth and nostrils, and it is probable that the green leaves of the herbage absorb this carbonic acid almost as soon as it escapes, and, appropriating the carbon, return oxygen to the animal to help its respiration and combustion. The animal as it eats continues to

grow and increase in bulk and value, whereas the artificial furnace in which the coal is burnt tends steadily to wear out and decrease in value. As it browses and grows, the droppings of the animal nourish the herbage, which here and there, by patches of more vigorous growth and deeper green, afford sure evidence of the value of these waste products.

In this arrangement there is no waste, for both the animal and the herbage, by a process of mutual exchange and the circulation of organic matter, increase in value.

Not only is there no waste, but, strange as it may seem, there is a positive gain, with no loss whatever. The furnace and the fuel are both increased! This increase can only be apparent, and not real, for it is well known that although we may alter the form of matter, we can add nothing to and subtract nothing from the sum total of the world.

One would say that this apparent increase is due to the stimulating effect of the excreta upon the soil, which enables us to draw something extra from that inexhaustible storehouse of plant-food and water, and enables the animal to use these materials, instead of allowing them to drain to the springs, and so find their way to the sea. We know that a far greater proportion of the rainfall percolates through barren soil than through soil bearing crops. If this be so, there is a practical increase of the land at the expense of the water.

Again, we must remember that our knowledge of the sources of the gases of the atmosphere is not complete. It may be that all the oxygen of the air is furnished by the green leaves of plants, and all the carbonic acid by processes of respiration and combustion, but we are by no means sure of this. Of the sources of the atmospheric

nitrogen we know nothing. Now it is certain that much of the carbon of the atmosphere is appropriated by the plants, and much of the oxygen by the animals. If among the herbage there be plants of clover, it is now certain that much of the atmospheric nitrogen will be drawn into the soil to nourish these plants and generally to increase their fertility. Whether the return of oxygen, carbon, and nitrogen is, in the long run, equal to the intake we cannot tell.

When, however, we ponder upon the gradual increase of vegetable soil or humus with which the bare rocks have been clothed in the course of ages, it is almost impossible not to come to the conclusion that the humus, and with it the fertility of the soil, has steadily increased at the expense of the sea on the one hand, and, possibly, of the atmosphere on the other. To put the matter in the form of question and in other terms, 'Does the *Lithosphere* increase at the expense of the *Atmosphere* and the *Hydrosphere*?' Does the land increase at the expense of sea and air? Be this as it may, it seems certain that by scrupulous return to the soil of all that comes out of it the resources of nature are made increasingly available for the benefit of man.

When organic matter is mixed with water, a process of putrefaction and fermentation is started, and the organic matter, instead of undergoing oxidation, is reduced, and among the commoner products of this process are ammonia with sulphuretted hydrogen and marsh-gas, which are both combustible. These processes furnish us with other combustible matters, among the commonest of which are the alcohols, the familiar products of fermentation.

It is interesting to note the tendency of organic

matter, when mixed with water, to give rise to explosive and combustible products. Explosions in cesspools and sewers have occurred many times. When wet hay is stored in stack it catches fire. When we stir the mud at the bottom of a pond or river, bubbles of combustible marsh-gas rise to the surface. The coal measures are due to the storing under water of semi-aquatic plants which have been preserved by being silted up, and we know that coal is full of olefiant gas, marsh-gas, sulphuretted hydrogen, and carbon monoxide, which are all combustible, and that the carbonaceous residue, charged with volatile and combustible hydrocarbons, forms the chief fuel of the civilised world. Peat is formed in ways analogous to that of coal, and the so-called mineral oils are certainly the products of organic matter which has been silted up.

These subterranean stores of combustibles, all of organic origin, are, as we know, prodigious in quantity. Nobody can predict the time which it will take to exhaust the coal measures of the world, and we know for a fact that the sacred fires of Baku, on the Caspian, fed by subterranean reservoirs of naphtha, have been burning for centuries.

When we see the end of a tin of 'preserved meat' bulged, we know that the gas-forming organisms have been at work within, and when the bed of the lower reaches of the Mississippi rises as a small mud mountain, spluttering with carburetted hydrogen, we know that analogous forces have been in operation. It seems, indeed, to be a law of nature that the ultimate destiny of organic matter is to 'circulate,' and that if it does not do so quietly, as in the ordinary processes of nutrition in plants and animals, it merely bides its time, and ultimately attains its end with more or less destructive violence.

Nitre (nitrate of potash or nitrate of soda) is an organic product, and sulphur is an essential constituent of all or nearly all organisms. Of the three ingredients of gunpowder, two (charcoal and saltpetre) are, it is certain, of exclusively organic origin, and the third, sulphur, may be so also.

All the common combustibles with which we are familiar are certainly of organic origin, and one is almost forced to the conclusion that in this world life must have preceded combustion. If we are to explain what *has been* by what *is*, such a conclusion is irresistible. Are we quite sure that volcanoes, which are seldom far from the sea, are not fed by old deposits of organic matter which has collected in the primeval ocean, and like the more recent coal measures, have been silted up?

What has been the destiny of the protoplasm of the countless animals and plants which are found in geologic strata? What part have ancient microbes had in the formation and disruption of the successive layers of which this earth is formed? These are questions which force themselves upon the mind, but which I will not attempt to answer. This biological view of the cosmogony which subjects the world, equally with all that is upon it, to the laws of development, evolution, and decay, does not, I believe, present so many difficulties as might at first sight appear.

Omne vivum ex vivo is a law of nature, and all organic bodies spring from organic antecedents. Organic matter is our capital in this world, and the more frequently we can turn it over, and the more quickly and efficiently we can make it circulate, the more frequent will be our dividends. If we burn organic matter we may get a good dividend of energy, but nothing further is to be expected. The construction of the furnace

involves an outlay of capital, which steadily diminishes as the furnace wears out by frequent use. If we burn organic matter merely to be rid of it, we spend our money for the sole purpose of dissipating our capital. The function of fire is to destroy and sterilise.

If we mix organic matter with large quantities of water, we have to encounter all the evils and annoyance of putrefaction, and if, when so mixed, we send it to the sea, we have no material gain of any kind. We spend our money for the purpose of dissipating our capital.

We may place the water containing the organic matter upon the land, and in tropical countries this is done, with excellent effect, for the production of rice, a semi-aquatic plant, which, according to Professor Georgeson, Professor of Agriculture in the Imperial University of Tokio, is said to prefer its nitrogen in the form of ammonia. The same authority states that nitrification does not take place under water, and careful experiments carried out at Tokio show that sulphate of ammonia is a much better manure for irrigated rice than nitrate of soda.

In our damp climate sewage farming has proved a dismal failure, and the difficulties seem to increase with the quantity of water which has to be dealt with. Excess of water drowns the humus, and nitrification cannot go on in a soil the pores of which are closed by excess of moisture.

The living earth, teeming with aerobic microbes, must be allowed to breathe. It needs for this purpose a certain amount (about 30 per cent.) of moisture; but it stands drowning no better than a man does, and if it be drowned, agricultural failure is inevitable.

If we carefully return to the upper layers of the humus, in which air and microbes exist in plenty, the

residue of everything which we extract from it, we inevitably increase the thickness of the humus and its fertility. Our capital increases, and our dividends increase and recur with a frequency which depends upon the climate.

With thrifty and high cultivation it may, indeed, prove profitable to compensate defects of climate by the use of glass and artificial heat.

The part played in the economy of nature by fungi and bacteria—the new learning of the last half-century—is an addition to human knowledge which is destined to revolutionise our views of many natural phenomena. It has already exercised enormous propulsive power on human thought, and has stimulated our imagination scarcely less than when, to use the words of Froude, 'the firm earth itself, unfixed from its foundations, was seen to be but a small atom in the awful vastness of the universe.'

This knowledge has provided us with a new world, peopled with organisms in numbers which, like the distances of the astronomers and the periods of the geologists, are really unthinkable by the human mind. Their variety also, both in form and function, is, for practical purposes, infinite.

When, with the help of the many inventions of the optician and the dyer, we catch a glimpse of things which a few years back were 'undreamt of in our philosophy,' and when we reflect that these organisms are certainly the offspring of 'necessity,' and are probably mere indications of infinities beyond, we cannot be too thankful for the flood of light which these discoveries have shed upon the enormity of human ignorance.

The lower animals and the lower vegetable organisms

(fungi and bacteria) co-operate in a remarkable way in the circulation of organic matter.

In the autumn the gardener, with a view to what is called 'leaf mould,' sweeps the dead leaves into a heap, where they are exposed to air and rain. This heap when thus treated gets hot, and one autumn I found that the temperature of such a heap had risen in the course of a week or so to 104° F., and remained at a temperature considerably above that of the surrounding air during the whole winter. On turning it over after a month or so one found in it a large number of earthworms and endless fungoid growths visible to the naked eye, and one felt sure that it was swarming with countless millions of bacteria, invisible except to the highest powers of the microscope. In the beginning of March this heap, much reduced in size, was spread loosely over a patch of ground which was previously dug. If one examined that ground to-day one would scarcely recognise the structure of leaves, and in a few weeks more it will have become nothing but ordinary garden mould, and anything planted in it will grow with vigour. This is a familiar everyday fact.

We know also that filth spread over a field by the farmer in the autumn or winter loses its offensiveness in a few days, and by the spring neither our eyes nor noses give us any clue to the cause of the fertility of the field which is covered with ordinary 'mould.' This process of 'humification' is largely due to earthworms and other earth-dwellers, which pass the earth repeatedly through their bodies, and in doing so reduce it to a very fine powder. I have examined worm castings picked off a lawn, and which, after being slowly dried, have been gently sifted through muslin. Those who have never examined a worm casting in this way will be interested to

know of what an impalpable dust the greater part is composed, and will also note the considerable size of the pieces of flint and grit which the animal has used in its living mill, and which have been separated by the muslin sieve.

These castings are full of microbes, and those who will take the trouble to scatter the smallest conceivable pinch of this impalpable dust upon a sterilised potato, after the manner and with all the precautions familiar to bacteriologists, will obtain an abundant and varied growth of bacteria and moulds, which will completely baffle their powers of enumeration and discrimination.

The greatest hindrance in the bacterial examination of the soil is this *embarras de richesse*, which makes the isolation of different species a matter of extreme difficulty.

The bacteria exist in the soil in countless millions, but it must be remembered that they get fewer as we go deeper. The first few inches of the soil are, in the matter of bacterial richness, worth all the rest, and at a depth of five or six feet they appear to be almost non-existent. The practical lesson which we have to lay to heart in applying this knowledge is that the upper layers of the soil are the potent layers in bringing about the circulation of organic matters, and that if we wish to hasten this process we must be careful to place our organic refuse near the surface, and not to bury it deeply, a process by which the circulation is inevitably delayed or practically prevented. If we bury it deeply we not only get no good, but we may get harm by poisoning our wells and springs.

It is the same with organic liquids. If these be poured on the surface, the 'living earth' (*i.e.* the humus stuffed with animal and microbial life) purges them of

their organic matter, and transmits a relatively pure liquid to the deeper layers. If they be taken to the barren subsoil direct, as in underground sewers and cesspools, they escape the purifying action of air and aerobic organisms, and inevitably poison the water. Filthy liquids accumulating in cesspools and leaking *under pressure* to our wells have cost us health and money incalculable.

Liquids poured upon the surface cannot, owing to the crumbly nature of the humus, exert any appreciable hydraulic pressure. This is a fact of huge importance in the practical management of organic refuse.

All effete organic matter instantly becomes the prey of animals and plants. The dead body of an animal teems with life—*Le roi est mort, vive le roi.* M. Mégnin, a skilled entomologist and a member of the French Academy of Medicine, has made a study, which is full of interest, of the living machinery which makes away with the bodies of animals not buried but exposed to the air and protected from beasts of prey.

M. Mégnin shows that the destruction of the animal is accomplished in no haphazard fashion, but that successive squadrons of insects are attracted by the successive stages of putrefaction.

The first squadron which arrives, sometimes before death and always before putrefaction, consists entirely of dipterous insects, house-flies and their relative, the blow-fly.

The next squadron are also diptera, and are said to be attracted by the commencing odour of decomposition. These squadrons use the carcass as a procreant cradle, and thus ensure the nourishment of the larvæ so soon as they are hatched. Amongst these flesh-seeking flies there

are said to be specialists which prefer the flesh of particular animals.

The third squadron is attracted when the fat begins to undergo an acid fermentation. These consist of coleoptera and lepidoptera, beetles and butterflies, and among them is *Dermestes lardarius*, the Bacon Beetle.

When the fats become cheesy the diptera reappear, and among them is *Pyophila casei*, the fly which breeds jumpers in cheese, and which is accompanied by a beetle, whose larvæ are attracted by rancidity.

When the carcass becomes ammoniacal, black, and slimy, it is visited by a fifth squadron of flies and beetles.

And these are succeeded by the sixth squadron, consisting of acari or mites, whose function it is to dry up the moisture and reduce the carcass to a mummy-like condition.

The dried carcass proves attractive to the seventh squadron, consisting of beetles and moths, some of which are the familiar pests of the housewife, the furrier, and the keepers of museums. These animals gnaw the softer parts, such as ligaments, and leave nothing but a fine powder behind them, which is in fact their dung.

The last and eighth squadron consists solely of beetles, which clean up the débris, in the shape of dung, shells, pupa cases, &c., of the seven squadrons which have preceded them.

M. Mégnin, being an entomologist and not a bacteriologist, deals exclusively with the insects concerned in making away with a carcass, but it is evident that bacteria work hand in hand with them.

There are many other instances which may be quoted of the co-operation of fungi with other organisms, and it

is only of late years that we have appreciated the fact of *symbiosis*, or the living together of two organisms for the mutual benefit of each. This fact was first pointed out in so-called lichens, which are now shown to be complex bodies consisting of a fungus and an alga, living in symbiotic community for the mutual benefit of each.

It was next shown that the papilionaceous leguminosæ are unable to flourish without certain bacterial nodules which grow upon their roots, and by the instrumentality of which they can appropriate the nitrogen of the air, and thus the fact, familiar for centuries, that the leguminosæ leave the ground in a state of great fertility, while they are singularly independent of nitrogenous manures, has been explained.

But if the plants themselves are independent of dung, it is not so, apparently, with the symbiotic nodules, which seem to flourish far more vigorously in rich garden ground than they do in comparatively poor farm land. Thus the late Sir John Lawes grew clover in a rich old garden for forty-two years, and had luxuriant crops every year.

According to my own observation on the scarlet runner bean these nodules are more plentiful upon the roots which grow superficially than upon those which run deeply.

Symbiosis is observable in many plants other than the leguminosæ, and it is certain that many of our big forest trees depend for their nourishment upon fungi which grow upon their roots.

All animals appear to be symbiotic, for we all carry about millions of microbes, which must fairly be regarded as junior partners in our economy, and which we cannot

do without. The microbe which has been chiefly studied —the *Bacterium coli commune*—appears to be essential for certain digestive processes which go on in the intestines while we live; and when we die, this microbe is active in starting the dead body upon that cycle of events which is one form of the 'Circulation of Organic Matter.'

Now it is certain that the dung of all animals swarms with bacteria and allied organisms when it leaves the intestines, and it seems highly probable that excrement carries with it the biological machinery which is necessary for its dissolution and ultimate humification.

My friend, Mr. George Murray, F.R.S., the keeper of the Botanical Department of the British Museum, whose learning in fungology is well known, has kindly furnished me with an elaborate list of 139 genera of fungi which flourish on excrement.

Of these 139 genera, Mr. Murray has tabulated no less than 628 species which are known to flourish on excrement.

Of the 628 species, 226 have been found on the dung of more than one genus of animals, but no less than 402 species of fungi are peculiar to the excrement of only one genus of animals.

Of these 402 species of fungi, 91 are peculiar to the dung of the ox; 78 to the horse; 68 to the hare and rabbit; 30 to the dog; 25 to the sheep; 28 to birds; 21 to man; 16 to the mouse; 9 to the deer; 7 to the pig; 7 to the wolf; and 22 to other animals.

This search for fungi in excrement is necessarily incomplete. In Mr. Murray's list it is evident that the greatest number of species has been found in the dung of animals which are domesticated and common, and which offer facilities to the fungologist. The numbers

are startling, but when we consider that the dung of every living thing which crawls or burrows, or swims or flies, has properties which are peculiar to it, and which fit it to become the nidus of some peculiar fungoid or bacterial growth, the part played by fungi in the distribution and circulation of organic matter cannot be over-estimated.

The facts which have been recounted, and which seem to show that fungi and bacteria are necessary for the growth and development of even the highest plants and animals, and that fungi and animals are equally necessary for the dissolution of organic matter, point to the conclusion that the correlation of the biological phenomena in this world is no less exact than the correlation of the physical phenomena. The uniform composition of the atmosphere, except under special and local conditions, is a fact which tends in the same direction.

CHAPTER V

THE HOUSE

By those who are content to live simply, the conditions of healthy living are easily attained.

A cottage (*orné*, if you like) built on a slight eminence or on the slope of a hill, well exposed to the sun, and with a quarter of an acre of land, is no Utopian idea. The idea is capable, be it observed, of contraction or expansion, but if the individual is to be *quite* independent of others for his healthy surrounding, a small plot of garden ground is absolutely essential.

The foundations of this modest house must be solid and dry, the walls thick, the windows big, and the roof water-tight.

There must be neither cesspools nor sewer, which are great and acknowledged causes of sickness. No filth or refuse must be allowed to accumulate, but it must be returned *every day* to the soil.

The rain-water which falls upon the roof should be kept for washing and cooking, if not for drinking; and it may be remarked parenthetically that there is no reason why rain-water should not be collected in an ornamental vessel rather than the dirty-looking water-butt or hideous tank which is now too much in vogue. It is far better to have an ornamental water-vessel in a prominent place, where it can be easily inspected, than

a hideous receptable poked away in some odd corner, where it is too often forgotten.

There are one or two points in the construction of dwellings which are of importance, and which do not receive sufficient attention from architects.

One is to have a maximum amount of light precisely in those places where filth is most likely to accumulate, in order that the filth and dirt may be easily detected.

Another is to let waste water be discharged at the highest level possible, in order that its filtration by gravitation through the earth, or any other suitable filter, may be easily arranged.

A third is not to allow the staircase to become a channel whereby the used air of the ground floor may float up to the first floor. Staircases should be shut off from the ground-floor apartments by means of a door.

It will be noticed that what has been sketched is within the reach of very moderate means. It is probably too simple, and will not be approved of by those who have longings after more pretentious residences and more artificial modes of existence.

Health depends upon our obeying the laws of nature; and the rule of nature which most affects our health is this, *that all refuse matter shall be restored without delay to our mother earth,* who will receive it gratefully, and give back a dividend. The greater number of our sanitary troubles are due to the neglect of this law. It will be noted that it is very cheap to live healthily. In the dwelling I have supposed there would be no sewer-rate, no water-rate, no plumbers' bills, very little sickness, and a good return from the well-cultivated and well-nourished garden.

A distinguished physician and sanitarian drew a picture of a city in which the laws of health were strictly

obeyed; he called his imaginary city the City of Hygeia. A City of Hygeia is hard to attain, and would involve immense expenditure and endless watching. A healthy cottage (call it Hygeia if you like) is easily attained, and is the cheapest dwelling imaginable for a civilised man.

Without cultivation of the soil there can be no high standard of health. The gardener and the farmer are, so to say, the right-hand men of the sanitarian. What the householder wants to be rid of, the tiller of the soil is ready to take. If the householder tills a bit of soil for himself all difficulties are at an end; if he does not, his difficulties begin. If the refuse of a single house be put on its own garden, there is no difficulty. If the refuse of a group of houses be taken to a neighbouring field or garden, the difficulty is slight, but the return is less, because the expense of transport has to be borne, and it must be remembered that refuse matter will not bear the expense of much carriage. If the refuse of a big town is taken to one spot, the delay in collection and other difficulties increase, and it is found that the expense of transport eats up the profit. It is evident that refuse should be utilised at the *nearest* available spot. If the refuse of London had been treated in this way, and had been carried to all the points of the compass for utilisation instead of being collected at one spot, it would probably have proved to be less of an incubus than it is at present.

This is the age of centralisation, of co-operation and big schemes; but in the matter of refuse disposal big schemes have not proved successful, for the very obvious reason that the greater the distance refuse is transported, the greater the loss. Refuse is valuable if used on the spot and immediately. Storage and transport diminish

the profit from refuse, and dilution destroys it altogether. Country towns would, it is tolerably certain, do well to carry their sewage to many points rather than one, and by so doing they would simplify their difficulties, and would be able to make use of the natural formation of the surface. It is tolerably clear that all sanitary authorities should cultivate the soil. Some have embarked in big schemes of sewage-farming, but the success of these schemes has often borne an inverse proportion to their size. Every town should be planted, and perhaps some day our country towns will be beautified by sanitary authorities instead of being simply disfigured. If the streets and roadways were planted, and if the trees thus planted were nourished with some of the refuse of the town, our country towns would gain in appearance and healthiness. At least, the putting of refuse matter to its proper use might convey a valuable lesson to the inhabitants.

It would almost seem that living is healthy in proportion to the simplicity and economy which are observed. Almost all expenditure on needless luxuries in the house involves some risk; and in order to illustrate this point it will be well to glance at the modern dwelling fitted with what are termed 'the latest sanitary improvements.'

In that excellent work, entitled 'Our Homes and How to make them Healthy,' published by Messrs. Cassell & Co., and edited by Mr. Shirley Murphy, the medical officer of the London County Council, will be found a series of articles by eminent sanitarians which are well worthy of study.

Mr. Thomas Eccleston Gibb, who writes on the legal liabilities of householders, warns us that 'there is no part of a house where builders are so likely to "scamp"

their work as the drainage, and they are probably in that point under the least amount of supervision by public authorities. A local surveyor may order the work to be done in a particular manner; but the work is done and covered up in his absence, and the nicely worded by-laws which hang in the builder's office are not more likely to be looked at by the builder than are the drains, when buried beneath the ground, by the officer appointed to see those by-laws carried out. Nothing short of an alteration in the system can remedy this great sanitary defect.'

The late Mr. Eassie, C.E., in a very able article, tells us of some of the difficulties and dangers of house drainage, and warns us:—

1. That the pipes sent by the maker are often so bad that the unloading of them at the railway station must be superintended by some one who represents the interests of the purchaser, and that the individual pipes must be inspected, and the bad ones rejected and returned to the manufacturer at his expense.

2. That pipes are often badly fired, too brittle, too rough on the inside, too thin and ill-fitting at the sockets.

3. That the laying of pipes is no easy matter. The ground may get sodden and sink away beneath, and thus the levels may get wrong and stoppages occur. Again, workmen will often maintain a level by means of wooden wedges, and these in time rot, and the proper level is lost.

4. That the joining of pipes demands great care. The sockets must fit and the cement be good; and we are warned that, if the cement projects into the interior of the pipe, the flow through the pipe is impeded and dangerous stoppages may occur. Again, it is common

to make a junction between a big pipe and a small one without a proper diminishing pipe, and then leakage is sure to occur, and the earth gets sodden.

5. That if pipes be laid (as often is the case) before the heavy building work is finished, they run a great risk of being broken by the falling of heavy bodies on the earth above them.

6. That pipes are so liable to become disarranged in some way that it is never safe to have them beneath a house. When they pass through the wall of a house they are very liable to break when the house settles; stoppages will occur, and the drainage will be penned back and become a source of danger.

[N.B. Houses are very liable to settle when they are built, as often is the case, on heaps of rubbish and rotting refuse.]

7. That pipes are very liable to get choked, the chief causes being (*a*) defects of manufacture or workmanship, as indicated above; (*b*) collections of sediment where the level becomes deranged; (*c*) collections in syphon bends, which, we are informed, are 'the best-abused article in a line of drainage;' (*d*) the congealing of fat from the kitchen; (*e*) the invasion of pipes by the roots of trees —for trees have a nasty trick of driving their roots where they can get nourishment.

8. That 'grease traps are necessary, especially when the scullery sink is at the furthest point from the sewer, as it is in the majority of London houses. These grease traps must be cleaned every two or three months, because they generate, during decomposition, 'very disagreeable smells.'

9. That having laid our drains, our next efforts must be directed to keeping back the foul air which will accumulate in a foul place; and 'traps' are necessary.

Their name is legion, and we are warned that the commonest of all (the bell-trap) is 'most reprehensible.'

10. That soil-pipes are too often made of badly socketed earthenware pipes, and when tested are not unfrequently found to leak at every joint and to be broken at the foot.

11. That as regards the proper material for soil-pipes, (*a*) zinc is too weak and must not be used; (*b*) cast-iron is not a bad material, but 'the vilest attempts at making a joint are perpetrated;' (*c*) lead is the best material, but then the lead must be thick enough and the jointing perfect.[1]

12. That the joints of soil-pipes must not be 'slip-joints, where one end of a pipe is slipped into the end of another and the space filled up with *no matter what*!'

13. That the soil-pipes must be properly fastened to the walls. We are told how, out of ten stacks of soil-pipes examined in a northern hospital, there was scarcely a sound joint found from want of this precaution!

14. That the soil-pipe (if it can be made air-tight) needs artificial ventilation, and the ventilator, of the same diameter as the soil-pipe, must be carried to a height of at least four feet above the highest window, and we must take care lest the birds come and build in it.

15. That 'it is constantly a matter of surprise and disgust to notice, especially in houses built for the working and middle classes, how often rain-water pipes are made to do duty for soil-pipes as well; how often the

[1] During a debate on the sanitary defects in houses which took place at the Parkes Museum, a story was told of an enterprising American who made a soil-pipe of old meat tins which he soldered together. The jointing in this case was sadly defective.

waste-pipes of baths and sinks are taken into such combined pipes; how these pipes always communicate at the foot with the house-drain, not disconnected from the sewer in any way; and how, very frequently, such pipes, doing double duty, terminate level with the top windows, giving off vaporous effluvia into the warmer room whenever the top sash is pushed down or the bottom one lifted.'

16. That it is necessary to disconnect the soil-pipe and the house-drain generally from the sewer, in order that the air of the sewer may be kept from the house, and a current of air circulate in the house pipes.[1] The means of disconnexion require an expert for the proper understanding of them, and we are warned that, 'Far too frequently, after an ordinary builder has produced what he terms "disconnexion and ventilation on modern lines," the bulk of the work has to be rearranged at considerable expense.'

17. That pipes and drains so frequently being stopped, it is advisable for the owner of a large house to keep on the premises proper cleansing rods and forcing gear.

Mr. Eassie having given a number of warnings as to what *may* occur in consequence of ignorance, bad workmanship, or accident, Dr. Corfield takes up the running, and from the store of his ample experience tells us what *has* occurred. Dr. Corfield tells us:—

18. How rats make runs from the drains beneath our houses and invade the house, and how they will run from a defective drain in one house, beneath a party-wall, and up the drain of the next house.

[1] It is evident, however, that the free circulation of air in the house-pipes must, especially in hot weather, favour the evaporation of water in syphon bends and lead to the unsealing of traps. (G. V. P.)

19. How he has found cesspools leaking into wells.

20. How drains have been found with an insufficient fall, or even sloping the wrong way.

21. How drains have been found not jointed at all, or jointed the wrong way, so that they must leak.

22. How it has been attempted to take a drain round a corner by means of two straight pipes, meeting at an angle, instead of a properly curved pipe, and how the open angle necessarily leaked.

23. How junctions are made by means of clumsy holes roughly knocked in a big pipe, in order to take the end of a small one, and how blocks and leakage are thereby brought about.

24. How the sewer air comes up the kitchen sink.

25. How rain-water pipes, and even special ventilating pipes, bring sewer air to the attic windows.

26. How the *upper end* of a soil-pipe has been allowed to remain open and terminate *inside the house.*

27. How the *lower end* has been found to have no connexion whatever with the drain.

28. How soil-pipes have been found traversing the wall of a larder, and how they have been perforated by the hooks and nails on which the mutton is hung.

29. How traps are often a delusion and a snare, and how, in addition to the bell-trap, the next commonest, the D trap, is worse than useless.

30. How lead quickly wears out and gets perforated.[1]

[1] In the Parkes Museum is an interesting collection of old lead sanitary fittings, which have been removed from houses, and which have been the cause of more or less illness in consequence of their becoming perforated, and thereby admitting sewer air to the house. Water-traps are of only partial use in keeping foul gases out of houses. The foul gases of the sewer are absorbed by the water on one side and given off on the other, and if there be foul gas in the sewer, the water of the trap is sure to become charged with gas quite independent of differences

31. How sewer air may come up the waste-pipe, or overflow-pipe of the cistern, and contaminate the drinking water.

32. How 'syphon bends' get emptied by suction or choked by deposit.

33. How pan closets and D traps get plugged and 'the container' foul.[1]

34. How valve-closets, solid plug-closets, washout-closets, and hopper-closets are each liable to their special and peculiar defects.

35. How special cisterns are necessary for the service of the w.c., and how outbreaks of typhoid have arisen from neglect of this precaution.

36. Finally, we are told how 'foul air often travels about houses by most unexpected channels. Rat-runs have already been mentioned; but besides these it travels under floors, behind panelling and wainscoting, along ventilating shafts, through defective flues, and even through the tubes in which bell wires are carried, through which foul smells from the basement, and still more frequently the products of the combustion of gas-burners, often ascend into rooms upstairs.'

A series of 840 careful experiments, carried out by a

of pressure or temperature. If the water in the trap evaporates (as is sure to happen in any sink or closet which is little used, and is in some forgotten corner), or if the water is sucked out by the flow of water past it from some pipe above, then sewer air has, of course, free access through an untrapped pipe. We never can see the state of our 'traps,' and we can only infer (and often wrongly) that they are sealed. A distinguished physician, speaking at the Mansion House in aid of the Parkes Museum some years since, spoke of the D trap as the 'double D trap, because it deals out Death and disseminates Disease.'

[1] The writer has seen the 'safe' of a pan closet, which is intended to catch slops which accidentally spill over, perforated by a bell wire, and the spilt slops soaking along the track of the wire.

special committee of the Sanitary Institute, to ascertain the quantity of water required to flush a water-closet, &c., have given some very interesting results. Thus in a 4-in. drain 50 ft. long, with a gradient of 1 in 40, it was found that, with a flush of two gallons, 5 per cent. of the material used remained in the closet trap, 27 per cent. stuck in the drain, 37 per cent. lodged in the disconnecting trap, and 31 per cent. 'cleared.' With a flush of three gallons, 1 per cent. remained in the closet trap, 1 per cent. in the drain, 25 per cent. lodged in the disconnecting trap, and 73 per cent. cleared. It is interesting to note that under no conditions tried in these experiments was the closet trap completely cleared of excrement; and that, with a drain 50 ft. long, in no case did less than 25 per cent. of the excrement lodge in the disconnecting trap. With a drain 26 ft. long, however, it was found possible to reduce the lodgment in the disconnecting trap to 16 per cent. When it is remembered that a trap is a device for producing a local stagnation, and that a trap filled with excrement or urine or soapsuds inevitably becomes foul; and when it is further remembered that these stagnant mixtures of fæces and water are typical 'cultivating chambers' for such microbes as grow in water, be they pathogenic or otherwise, it will be conceded that traps of all kinds are very undesirable adjuncts to the dwelling, and must be regarded as necessary evils for mitigating the dangers of a faulty system.

The above catalogue of common dangers in modern houses seems to show that, as all 'modern sanitary improvements' are liable to wear and tear, the danger arising from them (even assuming that they are all, to begin with, perfectly made and perfectly fitted) must be proportionate to the quantity used.

They all cost money, many of them are very expensive, and they all add to house-rent, or diminish the profits of the landlord.

When there is a small garden they are *all of them* unnecessary, and it is perfectly idle to contend that there is greater decency in the use of water apparatus than in the so-called dry methods. Dry methods do not open the door for the profit of patentees and others; but if a little of the ingenuity which has been devoted to the manufacture and subsequent exclusion of sewer air had been devoted to the easy use of dry methods of filth manipulation, many lives would have been saved and much money also.

It is the fashion of the present day to bring all that is nasty into our houses, even though those houses stand in hundreds of acres of parkland. And owners will spend thousands in order that they and their households may be in constant danger of sewer gas.

If Jonathan Swift had lived on into the twentieth century, assuredly Lemuel Gulliver would have been made to take a voyage to the modern Hygienic Laputa; and possibly Swift's wit and satire would have been able to bring people back to the straight road from which they have gone so dangerously astray.

Great cities which have got fast stuck in a sanitary quagmire must perforce pay large sums to have their troubles lessened; and to that end it is to be hoped that the almost endless clauses of Sanitary Acts will be of use. The modern duty of the individual in a city is to obey the law and assist in every way in its proper execution.

In rural and semi-rural districts, the individual ought no more to ask others to keep him clean than he asks others to feed him or clothe him. He ought to take a

pride in keeping his house wholesome and clean, and he ought to receive every encouragement from the authorities if he does so.

In connexion with the question of house construction, the author would venture to make a few additional suggestions without in any degree trenching upon the domain of the architect. Architects are educated for the most part in crowded centres, where the problem of how to get the greatest amount of accommodation on the smallest area is paramount, and it too often happens that the town-bred architect, when called upon to build a house in the country, is unable to cast away the unwholesome notions which have been engrained upon him in the city, and often fails sufficiently to appreciate that the building of a country residence is a problem quite distinct from the building of a town residence, and that nothing is so conducive to the comfort, beauty, and wholesomeness of a dwelling as is an ample area upon which to construct it.

In hospital construction the rule has been for many years absolute that the sanitary offices shall be in detached turrets, approached from the main structure by a short passage having thorough cross ventilation. If this is good for hospitals why is it not good for dwelling-houses? It is considered dangerous for hospital patients to live and sleep in an atmosphere polluted by sewer gas. Is it good for those who are well? In the planning of a country house, the kitchen and offices, cisterns, sinks, baths, w.c.s, &c., should be in an annexe detached, however slightly, from the main building, and approached at every floor by a lobby having cross ventilation. This annexe should contain no bedrooms, and on no account ought there to be any 'sanitary apparatus' within the four walls of the main structure. A bedroom, dressing-

room, bathroom, and w.c. *en suite* may be a very convenient arrangement, but it is an arrangement which has killed its hundreds, and ought never to be employed unless the bath and w.c. be in a detached turret and approached by a lobby having cross ventilation. The greatest luxury in a house is ample area, and no country house should be more than two storeys high.

I have lately seen two country houses, recently erected, each of them standing in an ample park. In the first of these the nurseries were at the top of the house in *a third storey*, so that the children should have a maximum amount of stairs down which to fall and should inhale all the used-up air which might drift up the staircase from the floors below. It is needless to say that these nurseries had sanitary offices almost in the bedrooms. The rest of the house, which in many respects was very beautiful, showed a similar amount of thoughtlessness in the sanitary arrangement, and the owner has since died with sore throat and pneumonia.

The second of these houses was equally beautiful. A picturesque entrance hall led to a fine Old English staircase, which conducted to the floor above. The reception-rooms, of course, opened into the hall, which in this way, and by the staircase, provided air, or might do so, for every room in the house. Opening by a door *in the entrance hall*, and with no separation except the door, was a lavatory with tip-basin and w.c., ready without notice to flood the whole house with poison. The other sanitary arrangements showed an equal want of thought, and it is needless to say that such a house could never be safe.

Again, I have lately seen a school which had to be closed in consequence of a slight outbreak of diphtheria. In this school (standing in twenty acres of ground) the

mistake had been made of not separating the sanitary offices from the main structure, and as the sanitary arrangements needed repair, it was necessary to delay the return of the boys until this had been done. In this school was a new building containing a dormitory, the staircase of which led direct to a big bathroom (with six or eight baths) in the basement. This arrangement ensured that if any effluvia came up the waste-pipes of the baths they might travel direct to the dormitory. In all schools, especially boys' schools, the sanitary offices, baths, lavatories, w.c.s, should be in separate structures, detached and approached by a cloister. If this were done it would be impossible to poison the boys in their bedrooms with the effluvia from drains. The accommodation in case of sudden sickness in the night should be in a detached turret. To allow boys to work or sleep under the same roof with a sewer-pipe of any kind is quite indefensible, because it is perfectly unnecessary. The closing of schools in consequence of outbreaks of filth disease is getting ominously common.

School buildings should not be more than two storeys high, workrooms below, dormitories above. It is not advisable to place one dormitory over another, or one classroom over another, because this unnecessarily increases the risk of epidemics, and it must always be borne in mind that children and young people are far more susceptible of infection than adults. The example set by the London School Board is not on any account to be followed.

What is true of schools is also true of barracks. A barrack should have ample area, and two storeys should be the maximum, and the British taxpayer ought to insist that the soldiers who cost him so much are not killed or rendered useless by sewer gas.

The Royal Barracks at Dublin, so noted for typhoid, have or had three miles of sewer-pipes beneath them. A soldier at home is supposed to be fitting himself for a campaign. He ought to be systematically taught 'field sanitation,' and ought not to be allowed to poison himself with sewers. I know something of a barrack in the South of England where the field-officers' quarters are four storeys high, with underground kitchens, and 'area gates' as in London. These houses are without a single square inch of private curtilage, but have all 'the latest sanitary improvements,' so that it was at one time found necessary to drive a champagne cork into the overflow-pipe of the bath 'to keep back the smell when the tide was rising.'

In connexion with the sanitation of the soldier the following account by Dr. Seaton of his visit to the Aldershot Sewage Farm on June 24, 1894, may be quoted: 'It is a misnomer to call it a sewage farm; it is in truth a sewage marsh, where pools of stagnant putrid sewage give rise to poisonous exhalations which, if the cholera infection were introduced, would soon prove to be of a most deadly character.'

Equally important with schools and barracks are hotels, not only because the fashion of living in hotels is on the increase, but because delicate persons and invalids who are sent to so-called health resorts have to reside in hotels which are generally, from the point of view of health, of the very worst construction. When a 'health resort' becomes fashionable its doom is sealed, because the value of land rises, and that crowding together of houses commences which always more than counterbalances the best hygienic efforts in other directions. The following remarks were penned after an autumn holiday, during which the writer had been 'hotel

poisoned,' and are inserted here by the kind permission of the proprietors of the 'Lancet:'—

It is a remarkable fact that by no means unfrequently the first idea which seizes on the mind of an hotel speculator or his architect is one which is essentially destructive. Having decided to *exploiter* this or that district by means of an hotel, he proceeds to erect a building which is absolutely out of harmony with its surroundings, and which tends to destroy, in so far as it be possible for one building to operate in that direction, those very characteristics which have made the locality famous or attractive. Instances will readily occur to the reader of localities which hotel-keepers have done their best to spoil. Notable examples are to be found at Arcachon, where the brute mass of a huge hotel towers above the surrounding villas and pine-trees; at Meiringen and Thun, in Switzerland, where, alongside of rows of chalets and quaint mediæval towers, the barren-minded architects have placed buildings of which the best that can be said is that they might pass unnoticed in a fifth-rate Parisian boulevard; and at Augsburg, in Bavaria, where the 'Drei Mohren,' a hostelry associated with Charles V. and the Fuggers, has been pulled down and re-erected after a model which is only too common. The first thing which the writer would impress upon hotel architects is to be careful to let the buildings harmonise with the locality. The hotel at which a traveller first alights on visiting a new district ought to serve as an introduction as it were, and prepare his mind for the pleasures which may be in store for him.

The most common fault in hotels is the fact that the buildings are too high, and occupy an area which is absolutely inadequate for the purpose. In big cities this may be a necessity, but no such necessity exists in

country places, and the main reason why country hotels are built on the model of town hotels is probably to be found in the very simple fact that, as I have hinted, most architects are town-bred. The provision of adequate area for the inmates is insisted upon by designers of hospitals, prisons, and similar institutions, and perhaps some day the same wise ideas will prevail with designers of hotels, which are institutions in which the inmates are ready to pay handsomely to be made really comfortable and to be maintained wholesomely. In hospitals an acre of ground is considered desirable for each hundred patients; and although this allowance may be excessive, it is well to bear in mind that when numbers are congregated under one roof it is absolutely necessary that area in proportion to the numbers be provided, and it is most important also to remember that even an excess of cubic space will not compensate for lack of area. Nearly all hotels stand upon a very deficient area; and almost all hotels when full present a degree of overcrowding which, from a sanitary point of view, is scandalous. Huge towering buildings, with as many floors as a warehouse, and perforated with staircases and hoists, so that each floor is 'ventilated' into those above and below, may be tolerated for a short time, but as places for prolonged sojourn or anything like permanent residence they are most undesirable. A resident in an hotel ought to be able to enjoy at pleasure either society or seclusion. In the public rooms he should find all that movement and gaiety which constitute the sole pabulum of dull minds, and which all of us enjoy at times; while, in his own apartment, he ought to find quiet and peacefulness in the highest degree. This end cannot be attained without adequate area, and it is notorious that one of the

greatest defects of modern hotels is the impossibility of being quiet until all the inmates are in bed and asleep. In an hotel where prompt service conduces so much to comfort, it is needless to say that the sources of supply should be equally accessible from all the living rooms. How to combine the possibility of seclusion with accessibility to the basis of supply is the problem for hotel architects to solve. It is probable that the best plan would be to place the offices and society rooms in a central structure, with the kitchen on the top floor, while the private rooms and bedrooms should be arranged in wings radiating from such central structures. The smell of the kitchen is a terrible fact in most hotels, and it is certainly surprising to find how infinitely rarely do architects take any trouble even to minimise it. I can recall one hotel, and only one (at Royat, in Auvergne), where the kitchen is placed on the top floor of the building; but I could name several in which the effluvia of the kitchen are conducted with infinite care into the bedroom corridors. The old-fashioned plan, which was common in England, of building inns round an open court and with open corridors, was good, and the fact that the court was really open probably prevented unwholesome effluvia from reaching the bedrooms. In the present day it is common to find the rooms arranged, not round an open court, but around the well of a staircase which is closed, and instead of two tiers of rooms, there are seven, eight, or even more. No worse design from the point of view of safety, comfort, or wholesomeness can well be conceived. With such a design there is no escape from noise or effluvia; there is a minimum amount of privacy, a maximum amount of labour in travelling from the front door to the rooms, and when these buildings catch fire we can only say: 'God help

those who live on the top floors!' And yet this is the commonest form of hotel, and the idea seems prevalent that the height of an hotel is nowadays immaterial, because the hydraulic lift abolishes (for the guests) the labour of going upstairs. That these lofty hotels enable proprietors to increase their accommodation without increase of ground-rent there is no doubt, but there is equally no doubt that, from the guest's point of view, they offer no advantages whatever, unless (which is very doubtful) they cheapen the cost of rooms. Of the hygienic disadvantages I have already spoken, and it remains only to be said that, in order to check the drifting of effluvia and noise from floor to floor, it is absolutely essential that staircases and lifts should be placed in buildings projecting from the main building and provided with independent ventilation. The loss of time and the labour which are involved by living at or near the top of a lofty building are self-evident. Theoretically, the lift reduces the expenditure of time and labour to a minimum, but practically the guest is often willing to incur the labour of mounting rather than wait for the lift. The cost of working these lifts is, as we have seen, very great.

I have incidentally mentioned the effluvia of an hotel. These are chiefly due to humanity, cooking, tobacco, and drains, and in an average hotel the admixture of these four ingredients is, I should imagine, very tolerably equal. It is not necessary to dwell at length on the so-called 'sanitary arrangements' of hotels, especially of Continental hotels. These arrangements are, as a rule, execrable; the closets are often of the worst type, the supply of water is generally deficient, and the sanitary offices practically always ventilate into the corridors or shafts of the building. In designing an hotel, provision ought to be made for placing closets and sinks in turrets

approached by properly ventilated lobbies, so that the impregnation of the main building with sewer air may be a little less certain than it is at present. In big country hotels there ought to be (as there is in every country house) proper and ample accommodation provided in the gardens (approachable by a covered corridor if necessary). In this way the strain put upon the internal accommodation would be lessened, and the indecencies often experienced in a big Swiss Kurhaus would be avoided. Certainly a gentleman's 'garden' ought to be provided as one of the sanitary accessories of an hotel, and it is probable that, properly managed, a similar arrangement would be welcomed by the ladies also. It is inconceivable to what extent this dangerous practice of keeping 'sanitary offices' within the walls of the main building is carried. Quite recently I visited one of the best known show places in Switzerland—to which a railway brings hundreds of tourists daily during the season. Arrived at our destination, luncheon was necessary, and for luncheon a visit was paid to one out of several big hotels. This hotel, built in a place where the price of land can hardly be excessive, was of the usual type, four or five storeys high, with a central staircase and shaft running from the entrance hall to the roof. The entrance hall simply reeked of paraffin and ammonia *plus* hotel. The paraffin came from the lamps, the ammonia from the closets, which opened directly into the central hall. These closets communicated direct, without traps, with cesspools which received the slops and excrement of this huge establishment. To step from the pure air of the mountain-top to the fearful atmosphere of this hotel was calculated to impress the mind of one who, having travelled to a spot where the air should have been absolutely pure, found that he was to run no small

risk of being poisoned while he ate his lunch! At luncheon one could not but remark the anæmic condition of several of the waitresses, and this was probably accounted for by the insanitary condition of the house.

In the present day, hotel advertisements generally lay stress on the fact that there are 'lifts,' a monosyllable which lets in a flood of light on the general plan of the building, and indicates with tolerable certainty that the area of the building is too small for the population it is designed to accommodate. Possibly some day we may have hotel advertisements couched in some such terms as these: 'This establishment, standing in extensive pleasure-grounds, has been designed on the model of a luxurious country house. The main building is only two storeys high, and has been so designed that all the bedrooms may be easily reached without any undue effort. The sanitary offices are detached from the main building. The public rooms are also detached, but they are central, equally accessible from all parts of the house, and so arranged that the smell of the kitchen cannot possibly prove an annoyance.' It is needless to say that every country hotel ought to stand in sufficient ground to enable it to be independent of any public sewer, and to deal with its own refuse in a manner which shall ensure the safety of the guests, render the soil increasingly prolific, and prove a source of profit to the landlord, rather than a perennial expense and nuisance.

Leaving the question of general design, we may consider some of the details of hotels. Thick party-walls and double doors are absolutely essential to ensure the quiet of the guests. The bedrooms, provided with these requisites, should be of a convenient form. On the Continent the hotel bedroom is generally too long and too narrow. The window is often too small, and so heavily

and ridiculously upholstered as to reduce its light-giving power to a minimum. This arrangement ensures that the end of the room furthest from the window is nearly always dark, and as the looking-glass is placed against one of the side walls, the difficulties of the toilet are very great. The bedrooms are often needlessly high, and not unfrequently there is a space of two feet or more between the ceiling and the top of the window. In 'summer hotels' the bedrooms have no chimneys, so that it is impossible to get a current of air through them without opening the door, and the opening of the door generally means the admission of suffocative vapours from the corridor. Every hotel bedroom should have a covered balcony so arranged that in winter it can be enclosed by outside windows. A balcony is in summer a very pleasant addition to a room, but as an adjunct to an hotel bedroom it is necessary, in order to afford the occupant a place for shaking and brushing dusty clothing—a process constantly necessary for a traveller, but one which cannot be performed except in the open air. It is as well to state that the balcony is more common in Continental than in English hotels. The thoroughly well-designed hotel bedroom, carefully 'fitted' rather than furnished with an eye to the comfort and well-being of the occupant, is one of those things which may be found when upholsterers do not happen to be the chief shareholders in hotel companies. In one particular, hotels on the Continent are uniformly first-rate, and that is in the excellence of the beds. These are always comfortable, and very superior to the beds which are found in many English hotels. Of the rest of the furniture, the less said the better; but I cannot refrain from commenting on the perverted genius of the man who invented the chest of drawers and washstand in one, so designed that one's

clean shirts are almost inevitably invaded by a flood of soapsuds. In a tour of twenty-eight days, 75c. per diem, or a total of 21 fr., was paid by the writer for the tin vessel, and some two gallons of water, which the Englishman (especially when engaged in active exercise) has the arrogance to demand for the purpose of cleansing his skin. One need not grumble at the sum paid, but certainly one has a right to grumble at the difficulty often experienced in getting this customary sitz-bath. Perhaps, when the Germans have written a few more treatises on 'Haut Cultur,' hotel proprietors will provide as a matter of course that which is now wrung from them with difficulty. The writer can only recall one hotel in which he has found a sitz-bath supplied without asking, and that hotel was at Malta, and it is probable that the landlord had been drilled in this particular by officers of the English garrison.

CHAPTER VI

AIR

We all know the importance of fresh air. Our instincts have told us this from all time. Nowadays every child is taught in the Board Schools the scientific proofs of why we need fresh air, so that any lengthy disquisition of this point will not be necessary.

Air which has been breathed once is poisonous, and a man in an hermetically sealed room would soon die.

The constant admission of fresh air to rooms is an absolute necessity, and were it not for chimneys, ill-fitting doors and windows, keyholes, chinks and crannies in the walls, and the accidental opening and shutting of doors, suffocation would be a far more common mode of death than it is.

It is not advisable to give less than 1,000 cubic feet of space to each occupant of a room. In prisons, each cell contains about 800 cubic feet of space, and, says Professor de Chaumont, 'practically this is found to be too small.'

Each gas-flame or lamp uses up the air just as a human being does, so that, in calculating the amount of cubic space necessary, we must reckon each lamp or gas-burner as an individual. It must be remembered that great cubic space is of no use unless inlets for fresh and outlets for foul air be also provided.

Ordinary churches are, as a rule, very badly ventilated. The cubic space is enormous, but its quantity is due entirely to height. The area in proportion to the congregation is very small indeed, and the 700 or 800 people in an ordinary church almost touch each other. In addition to the people there are often a great many gas-burners. There is often no ventilation, and it is a growing custom to replace the plain window, which might be opened, but seldom was, by a painted window which cannot be opened even if desired. What is the consequence of all this? The people give off their 120 gallons per head per hour of hot foul breath; this ascends towards the roof of the nave, and being cooled, sinks (for carbonic acid is heavy) and envelopes the congregation, as it were, with a soporific pall. Some faint, others go to sleep, and the preacher, poor man! perhaps fancies that the sermon, and not the carbonic acid, is the narcotic which has acted on his flock.

We live in an age of public meetings, and throughout the country there are hundreds or perhaps thousands of gatherings every day for the purpose of discussing questions of public interest. How few of these meeting-rooms are adequately ventilated; and how much harm is done by sitting for hours and breathing your neighbour's breath almost undiluted, it would be difficult to say! It is tolerably certain that 'colds' are caught by sitting in foul rooms. If air is deficient in oxygen and is loaded with organic vapours, the elimination of refuse matter from the blood does not go on properly, and when we have reduced our bodies to a state to be affected by any untoward circumstance we suddenly chill the surface by opening a window or going into the cold night air, and then we blame the latter circumstance

only, and give little attention to the two or three hours' preparation for mischief which we had previously undergone.

The *open air*, even in the most crowded London streets, is always infinitely more pure than the air of even well-ventilated rooms. The reason for this is that the volume of our atmosphere is, as compared with the volume of foul air which escapes from our houses, almost infinite, and the dilution which foul air undergoes is infinite.

A consideration of the above fact throws no little doubt upon the teaching of some of our hospital architects, who insist upon the necessity of separating the various pavilions containing the sick by enormous interspaces. As long as the air admitted to a sick-room comes really *from the outside* that air will be practically pure, and it will make no appreciable difference whether the next pavilion is 50 or 1,000 feet away. We must be sure, however, that the air employed for ventilation is really outside air, and that it has not been used before in kitchens, or more noisome places, and is not merely allowed to drift from one part of a building to another, whether by staircases, corridors, lifts or shoots.

The air which has been fouled by the respiration of men and animals, by the combustion of gas, oils and fuel, and by the exhalations from filth, is not only being constantly diluted, but it is constantly being purified. What we give off, plants need; what plants give off, we need. The carbonic acid which escapes from our breath is absorbed by the green leaves of plants, which convert the carbon into starch and allied bodies, and give back a great part of the oxygen in a pure state. During night, it is true, plants give off carbonic acid, but it is

equally true that at night the respiratory needs of men and animals are at a minimum. The influence of light, therefore, by stimulating the elimination of oxygen by green leaves, has great power over the condition of the atmosphere. Analyses of air show that there is less carbonic acid in the neighbourhood of luxuriant vegetation than where vegetation is absent. This difference is not great, because of the very free movement of the atmosphere, but it is quite enough to be measurable. In close courts of cities the carbonic acid is notably increased; and in crowded places, such as schoolrooms and theatres, the amount is dangerously great.

Although rare, it is well to bear in mind that infection can and does travel through the open air from house to house. This was well illustrated in the classic instance of the spread of small-pox from the Fulham Small-pox Hospital. Several similar instances have since occurred.

There are certain poisons which seem to travel mainly through the air. These are influenza, measles, whooping-cough, small-pox, typhus fever, scarlet fever, diphtheria, mumps, and chicken-pox. Typhoid fever may also travel through the air, and recent investigations have shown that that commonest of common diseases, consumption or phthisis, is distinctly communicable through the air. We have seen that contagion in the open air is so diffused that it is more likely than not to be harmless, even supposing that it is not destroyed. In dwellings the risk of contagion through the air is very great, and a case of measles or whooping-cough, even though it be confined to one room in a house, is very likely to infect any other children who may be in the house. In overcrowded and ill-ventilated

rooms, contagious particles which are given off have but little chance of escape, and are very likely to be inhaled by somebody else. Crowded gatherings of children must be reckoned among the great causes of the dissemination of many of the diseases of childhood. The risks of contagion through the air are diminished in proportion to the thoroughness of the ventilation.

It is an undeniable fact also that consumption of the lungs has been in many places greatly diminished by proper ventilation and also by proper drainage, thereby causing greater healthiness and dryness of the dwelling, and getting rid of a sewage-sodden soil.

There can be no doubt that our moral responsibilities with regard to the air we breathe are very great. Our first duty is not to foul the air more than we can help, to keep all about us clean and pure, and not to allow heaps of evil-smelling refuse to collect about our dwellings.

Our next duty is to see that a proper supply of fresh air is admitted to our dwellings. If this be done there will be a higher standard of health in the dwelling, more food will be needed, more work will be done. Of the economy of giving an ample supply of fresh air there can be no doubt. Employers of labour should remember this, and especially those who employ young people. All workrooms should have ample cubic space and free admission of air. The master will then have more work done, and more cheerfully performed, than otherwise would be the case.

Take care that every gas-light is provided with a flue communicating with the outside air. There is no real difficulty in accomplishing this; and if it be done, not only will the gas-light not *foul* the air, but it will aid in

the ventilation of the room just as the fire does, by creating a draught up its little chimney.

In schoolrooms and other places where mental work is to be done, good ventilation is of the greatest importance, and has a very great influence on the quality of the work done.

We must all of us try to set a good example in this matter of cubic space and ventilation. When, for example, we wish to show hospitality to our friends, we must remember not to stint the supply of the prime necessary of life. The average London dining-room is perhaps 20 ft. by 16 ft. by 12 ft., and contains, inclusive of the space occupied by furniture, &c., less than 4,000 cubic feet, or space considered sufficient for five convicts in prison. If we wish to do honour to our guests we invite sometimes as many as eighteen, and to wait upon them we employ four servants, and we light the room with half a dozen lamps or their equivalent—*i.e.* we put into our 4,000 cubic feet of space the equivalent of twenty-eight people, and we give them 143 cubic feet of space each, and as we provide no adequate inlet or outlet for fresh air, it is not to be wondered at that the discomfort often reaches agony point, and that the conversation lags; nor is it a matter of surprise that the average London dinner, where you are suffocated and overfed, is reckoned among the duties rather than the pleasures of existence, and that the malaise of the following day is (often wrongly) attributed to the quality of the wine.

The 'At Home,' where 150 persons (not reckoning the lights) crowd into about 8,000 cubic feet of space, with something like 50 cubic feet of space each, is, as is demonstrated by arithmetic, as nearly as possible three times as bad as the dinner. Perhaps the day will dawn

when it will be considered 'bad form' to give your guests not more than one-twentieth of the cubic space, and far less than one-twentieth of the fresh air, which is allotted to criminals.

Again, will nobody set us an example of keeping good hours? 'Early to bed and early to rise,' says the old proverb, 'makes a man healthy and wealthy and wise.' If we keep what are known as 'bad' hours, we are perforce obliged to spend those hours in rooms artificially lighted and warmed, and instead of breathing fresh air we breathe foul. The evils arising from this need not be dwelt upon. Such a state of existence is hardly compatible with good health. The M.P. at the end of the session, and the young lady at the end of the season, are standing examples of this fact. During the summer there are about fifteen hours of daylight and nine of darkness. It is the fashion to rise about seven hours after sunrise, and to retire about seven hours after sunset, and the masses follow the leaders of fashion. Will anybody calculate the unnecessary waste of gas and other illuminants caused by our obstinate refusal to make use of the sunlight? How many cubic feet of carbonic acid and sulphur compounds are poured into the London air in consequence of this perversity? How much unnecessary smoke is poured into it from the same cause? What advantage, if any, is got by converting night into day?

Not only is the air fouled by respiration and combustion, but also by putrefaction, and when considering the fouling of the air of London, one must remember the dung-heaps of the stables, and droppings of the streets, and the effluvia which escape from the ventilators of the 2,000 miles of sewers which lie beneath our streets. When we consider the magnitude of the

fouling of the air from various causes, and when we bear in mind that a fair percentage of the inhabitants are suffering from phthisis, pneumonia, influenza, scarlet fever, whooping-cough, measles, and diphtheria, and when we remember that a large number who are not suffering from definite disease have unwholesome breath as a result of pathological conditions of the teeth, mouth, and air passages, we cannot be surprised that a stagnation of the air should produce effects more or less disastrous. London can have very little power of purifying its air. Vegetation of all kinds is scanty in the central parts of London, and evergreens merely degenerate into everblacks and die. Even if green leaves did exist, their chlorophyll could not act in a place where, for a month at a time, there is no sunshine.

According to Dr. W. J. Russell, F.R.S., the amount of coal used in London (excluding that needed for gas-making) was, in 1879, 5,833,891 tons, while in 1889 the amount had risen to 6,390,850 tons, an increase which is about proportionate to the increase in population.

Nobody who is an early riser can doubt that the domestic fireplace is the main cause of the smokiness of London. At six o'clock in the morning the air is not unfrequently clear and brilliant, but these qualities disappear an hour later, when the preparations for the morning meal have necessitated the lighting of the fires. The amount of smoke is probably greatest between 7 and 8 A.M., because the best of grates will emit more or less smoke when just lighted. Later in the day the domestic smoke diminishes, and one must admit that it is not common to see the domestic chimney emitting very much black smoke.

Notwithstanding that factory smoke has been practically abolished in London, and that many causes have conspired to diminish the amount of domestic smoke per head, the dirtiness of the air and the number of fogs have increased.

In the country the smoke of our houses is blown away and diluted, and causes us no practical inconvenience; but in London we have not only been building upon every vacant space, but we have been increasing the height of our dwelling-houses and building towers full of offices and huge piles of flats, and we clearly have no cause to grumble if the air gets dirtier, and the death-rate does not go down. We have legislated against back-to-back dwellings, and yet allow them to be piled nine and ten in a heap, which seems to suggest that there is one law for the rich and another for the poor. That the increased frequency of fog is due to the increase of area and density there can be no doubt. There are more men and chimneys on a given space, and therefore the effluvia are less frequently diluted to vanishing point.

The physical and chemical aspects of London fog are of great interest. Aitken has shown that fogs do not form in a pure atmosphere which is absolutely free from floating dust particles; but as there is enough dust in the air off the coast of Newfoundland to allow of the formation of fogs of impenetrable density, it is obvious that the practical bearings of this interesting discovery as affecting the air of cities are not very important, for it would be manifestly impossible to get the air of London or any big town to such a degree of cleanliness that fog would not form. The chemical impurities which are found in the air during a fog are both gaseous and solid. Car-

bonic acid and sulphur dioxide are the more important gaseous impurities.

Dr. Russell has found the carbonic acid during a fog to be raised from four parts to fourteen parts in 10,000 of air; and a committee of the Manchester Field Naturalists' Society have shown that the amount of sulphur dioxide present in the air of that city may vary from 0·28 milligram per cubic metre (an amount observed at Owens College, Manchester, on March 6, 1891, after two days' strong wind) to 7·40 milligrams per cubic metre (an amount observed at the Town Hall, Manchester, on February 27, 1891, during a fog). The amount of impurity increases as one passes from the outskirts to the centre of a town.

The Manchester Field Club have further estimated that during a three days' fog 1½ cwt. of sulphuric acid per square mile was deposited in the centre of Manchester, while at an outlying station 1 cwt. of sulphuric acid and 13 cwt. of 'blacks' per square mile were carried down in the same time.

Those who have a garden anywhere on the western side of London cannot fail to remember a fog in February 1891, which covered the evergreen shrubs with a slimy deposit, and gave an iridescent appearance to all the puddles in the road. Happily the fog was subjected to scientific investigation. The matter deposited on Messrs. Veitch's Nursery at Chelsea, and that on a plant house at Kew, were analysed. At Chelsea twenty square yards of roof gave 40 grams of deposit, while at Kew the deposit on the same area amounted to 30 grams. It is interesting to note that not only was the deposit more copious at Chelsea than at Kew, but it also contained a larger percentage of hydrocarbons and acids.

The following is the analysis of the deposit at Chelsea:—

Carbon	39·00
Hydrocarbons	12·30
Organic bases	2·00
Sulphuric acid	4·30
Hydrochloric acid	1·40
Ammonia	1·40
Mineral water (chiefly silica and iron salts)	33·80
Water (estimated)	5·80
	100·00

That these deposits proved ruinous to plants goes without saying, for the leaves were choked by it. The large amount of acid and hydrocarbons in the air also explains the intensely irritating nature of a typical London 'pea-soup' fog, and certainly a contemplation of this analysis makes it impossible to believe that the mortality accompanying a London fog is due entirely to the cold, as some have maintained. The corrosive power of London air is seen in its destructive action on metals. We all know how the metal fittings in our houses tarnish and corrode, and we all know that bronze statues exposed to the London air quickly contract a worm-eaten appearance.

The air of London is never 'fresh,' a quality which is to be gauged entirely by the nose. Although we may be in doubt as to the physical or chemical basis of 'freshness,' we are most of us inclined to attach great importance to it as one of the most valuable qualities which air can have. It is the necessity of fresh air which has compelled us to supplement the London hospitals with a large number of convalescent homes at the seaside and elsewhere, because experience has shown that the power of recovery after acute illness in London or any large town is very much less than it is in the country. This quality of freshness consists in

an absence of foulness, a condition of things which cannot exist for many miles to leeward of a big city like London. It is also almost certain that the air cannot be fresh unless there be green things to freshen it. The chlorophyll of the green leaves of plants under the influence of sunlight is constantly engaged in absorbing carbonic acid *from* and returning oxygen *to* the air, and on this account it is tolerably certain that vigorous herbage is necessary for the freshening of the atmosphere which we breathe.

In the centre of London comparatively few plants will live, and fewer still will flourish; and even those which do flourish have to contend with an absence of sunlight, which is very prejudicial to the vigorous action of the chlorophyll. It thus follows that the regenerative power of the air in the centre of London is very small; we become entirely dependent upon the wind for our fresh air, and the stagnation of the air is consequently a more serious matter in London than it is elsewhere.

Thus one is led naturally to the discussion of another fact which is all too evident in London—viz. the absence of sunlight.

There can be no doubt as to the importance of sunlight. We know that the activity of the chlorophyll of plants is directly proportioned to the amount of sunlight, and we know that plants deprived of sunlight become etiolated and pale. When we see the radiometers rotating in the opticians' windows we have a demonstration that sunlight is a cause of motion, and all the wonders of photography are calculated to impress upon us the influence of sunlight upon chemical action. We know also of certain things which love darkness rather than light, and among them are the vegetable bodies which contain no chlorophyll, such as the fungi, inclusive of

many of those which are recognised as direct causes of disease. It has been proved with regard to some of these disease-causing microbes that exposure to the sun's rays materially inhibits their growth.

In the second report to the Royal Society Water Research Committee on 'The Vitality and Virulence of Bacillus Anthracis and its Spores in Potable Waters,' by Professor Percy Frankland and Professor Marshall Ward (assisted by Dr. Cartwright Wood), the reporters say (p. 316):—'17. To summarise our results with anthrax spores in one sentence, we may state generally that there is one natural agency at least which is capable of destroying them in surface waters to which they have gained access—viz. the action of direct sunshine on the organism. Whether the activity of water bacteria may be added as a second bactericidal agent is not definitely determined, but, in any case, of these two influences the sunshine is by far the more rapid and the more potent, though its sphere may be much more restricted.'[1]

It is further stated that the anthrax spores were selected for these experiments 'as representative of the extreme limit of endurance possessed by pathogenic bacteria.'

These facts make it certain that the presence of sunlight is most important for the well-being of mankind, and the Italians have a proverb which says that the doctor is sure to visit those places where the sun never comes.

Nevertheless we know very little that is accurate concerning the effect of sunlight upon the animal economy. It is probable that the pallor of town-dwellers is in part owing to the absence of sunlight, and it is certain that pallor must mean a deficiency either in the quantity or

[1] *Proceedings of Royal Society*, vol. liii.

quality of the hæmoglobin, the red matter of the blood which is apparently analogous to the chlorophyll of plants. Such a deficiency must interfere with metabolism and development, and it seems impossible not to believe that the want of sunlight is a factor in the causation of rickets, the commonest of all the diseases of London, albeit that it makes very little show in the returns of the Registrar-General.

Thus far we seem to have arrived at the conclusion that the increase in fog and darkness in London is a natural consequence of the increase both in area and density of the city, whereby too many fireplaces are packed on a given area.

Of late years, what may be called a new phenomenon in connexion with the air of London has frequently been observed—viz. the high fog or high darkness, which, while leaving the streets quite free from mist, effectually shuts off the light of the sun, and gives us a darkness in every way comparable to the darkness of night. This must be due to a bank of fog hovering over the city, and the explanation of this new phenomenon is probably to be found in the enormous increase in area which the city has undergone of late years. The smoke of some densely populated outlying part is caught as it were in a passing cloud of vapour, which, drifting far over the tops of the houses, acts as an absolutely opaque screen between us and the sun.

The dirtiness of London air being mainly due to the density and area of the city in the matter of people, houses, and chimneys, can nothing be done to lessen the density? I am afraid the answer to this must be that such measures do not come within the range of practical politics. London is regarded as a place for making money in, and people who come to it for that

purpose are extremely unwilling to be pestered with vital statistics.

That London will go on for some time yet getting progressively worse there can be little doubt, but, nevertheless, it is useful to point out how its troubles have arisen, for although one may have no local feeling for what Cobbett called 'the Wen,' one would be sorry to see her bad example in sanitary matters recklessly imitated.

We may admit that it is not a matter of very great consequence whether the death-rate of London be high or low, and we may feel very confident that if its inhabitants were polled as to whether they would like a lowering of death-rate or an increase of trade profit, they would choose the latter.

CHAPTER VII

WATER

Water is an article of first necessity to all of us. Without pure water there cannot be health. Pure water has served moralists of all times as a symbol of purity. The Christian Sacrament of Baptism is an instance of this.

Our moral responsibility with regard to water should be to respect its purity as something too sacred to be defiled. In this Christian land, however, there is scarcely a watercourse which is not polluted, and many of our loveliest rivers have been wantonly converted into sewers.

In his introduction to 'The Crown of Wild Olive,' Professor Ruskin gives an eloquent description of our swinish apathy with regard to water. The passage is so beautiful, that no apology is needed for quoting it in full:—

'Twenty years ago there was no lovelier piece of lowland scenery in South England, nor any more pathetic in the world, by its expression of sweet human character and life, than that immediately bordering on the source of the Wandle, and including the low moors of Addington, and the villages of Beddington and Carshalton, with all their pools and streams. No clearer or diviner waters ever sang with constant lips of the hand which "giveth rain from heaven;" no pasture ever

lightened in spring-time with more passionate blossoming; no sweeter homes ever hallowed the heart of the passer-by with their pride of peaceful gladness—fain hidden, yet full confessed. The place remains (1870) nearly unchanged in its larger features; but with deliberate mind I say, that I have never seen anything so ghastly in its inner tragic meaning—not in Pisan Maremma—not by Campagna tomb—not by the sand-isles of the Torcellan shore—as the slow stealing of aspects of reckless, indolent, animal neglect over the delicate sweetness of that English scene. Nor is any blasphemy or impiety, any frantic saying or godless thought, more appalling to me, using the best power of judgment I have to discern its sense and scope, than the insolent defiling of those springs by the human herds that drink of them. Just where the welling of stainless water, trembling and pure, like a body of light, enters the pool of Carshalton, cutting itself a radiant channel down to the gravel, through ways of feathery reeds, all waving, which it traverses with its deep threads of clearness, like the Chalcedony in Moss-agate, starred here and there with the white Grenouillette; just in the very rush and murmur of the first spreading currents, the human wretches of the place cast their street and house foulness; heaps of dust and slime and broken shreds of old metal, and rags of putrid clothes, which, having neither energy to cart away, nor decency enough to dig into the ground, they thus shed into the stream, to diffuse what venom of it will float and melt, far away, in all places where God meant those waters to bring joy and health. And in a little pool behind some houses further in the village, where another spring rises, the shattered stones of the well, and of the little fretted channel which was long ago built and traced for it by

gentle hands, lie scattered, each from each, under a rugged bank of mortar and scoria, and bricklayers' refuse, on one side, which the clean water, nevertheless, chastises to purity; but it cannot conquer the dead earth beyond; and then circled and coiled under festering scum, the stagnant edge of the pool effaces itself into a slope of black slime, the accumulation of indolent years. Half a dozen men, with one day's work, could cleanse those pools and trim the flowers about their banks, and make every breath of summer air above them rich with cool balm, and every glittering wave medicinal, as if it ran, troubled only by angels from the porch of Bethesda. But that day's work is never given, nor, I suppose, will be; nor will any joy be possible to heart of man for evermore, about those wells of English water.'

If poetry may be defined as the art of conveying absolute truths in the most beautiful and forcible language attainable, of at once compelling the intellect and gratifying the senses, then the above passage must take a high rank among short English poems, for its beauty is equalled by its matter-of-fact truth.

Unfortunately for the purity of English waters, the Public Health Act of 1848 encouraged the emptying of town sewage into rivers, and we are still taught as one of the chief tenets of our sanitary creed that we should dirty as much water as possible in washing away from our houses filth which ought to be buried. As a consequence of this, pure water is becoming daily more difficult to get, and nowadays it is considered safer and better to drink water—hard, charged with carbonic acid, and deficient in oxygen—which has been raised at infinite cost from the depths of the earth, than to drink of the 'brook which babbles by,' with every bubble freshened

by the air and charged with its maximum amount of oxygen. The reason for this is that the brook has almost certainly been fouled by receiving the filthiness from dwellings nearer to its source, and the natural consequence is the reflexion that, if the brook has already been fouled, a little more fouling can do no harm, and thus the brook gathers sewage as it flows, till, having passed through sundry towns in its course, it flows out to sea a seething, stinking sewer.

We all of us deplore this state of things, but few of us, in thinking of the cause of such filthy impurity, ever pause to put to ourselves the solemn question, 'Is it I?' We inveigh against the 'Board,' we say that such a state of things is disgraceful, we shut our eyes to the fact that the disgrace falls upon ourselves as well as others; and even though we may be favourably circumstanced for doing our duty towards the watercourses, the pangs of conscience are seldom sufficient to make us stop our quota of pollutions; at least to do our own duty, and, doing it, set a good example to others.

Richard the Second (whose advisers probably remembered the epidemics of 'the Black Death' in the reign of his grandfather) passed an Act in 1388 which imposed a penalty of twenty pounds (worth how much of our money?) on persons who fouled ditches and rivers with filth and refuse, and in 1876 Parliament passed an Act intended to save rivers from pollution. This Act is put in force against 'Boards' and 'Authorities' (with how much success the Thames, the Mersey, and the Clyde will testify), but is seldom enforced against individuals; and although it is often easy for an individual to cease polluting a watercourse, it is often impossible for a sanitary authority to do so in the face of the apathy

of the individuals by whom the members of the 'Board' have been elected.

Not unfrequently the 'Board' is content to let the individuals alone, because millions spent in sewers and other millions spent in waterworks is 'good for trade' in general, and, possibly, specially good for the special trade of some of the members of our local parliaments.

The demon of self-interest has always to be reckoned with when devising measures intended to benefit the public health.

Many diseases are caused or conveyed by impure water, the most notable being cholera and enteric fever. Let us take the commonest of these diseases, enteric or typhoid fever. The patient who is attacked with typhoid is attacked insidiously; he suffers from the disease, generally days, sometimes weeks, before its nature is recognised. The poisonous excreta of this patient pass into a watercourse, or perhaps into a cesspool (a pit in which excrement and water are commingled), and the water leaks from the cesspool into the well, and then those who drink of the well suffer in their turn from typhoid.

Water thus poisoned by leakage usually bears evidence, both physical and chemical, of its contamination, but this does not appear to be necessarily the case, and there are instances of tainted waters being pleasant to the eye and palate.

That the germs of cholera and typhoid will live in water is certain, and their power of diffusion through water is infinite. One dejection from a typhoid patient is theoretically capable of infecting an almost unlimited volume of water. The mischief which one case of typhoid may do is told by the late Professor de Chaumont in 'Our Homes:'—

'A very remarkable case was investigated a few years ago by Dr. Thorne Thorne at Caterham and Redhill, Surrey. The Caterham Water Company found that they were unable to supply the whole district with their existing arrangements, and in the more remote part of the district they were obliged to get part of their supply from a neighbouring company. In the meantime they determined to enlarge their sources of supply by digging additional wells, and cutting and enlarging the adits from one to the other. Careful arrangements were made to prevent contamination of the water during the work, and the men were instructed to carefully avoid fouling the water with any excremental matter. One of the workmen, newly taken on, was suffering, unknown to himself, from a mild attack of typhoid fever, accompanied with diarrhœa, and he confessed that he was obliged not only to have resort to the buckets, but even to make use of the adit itself, on emergency. About twelve or fourteen days after he began to work typhoid fever began to show itself among the consumers of the water; the disease spread rapidly, and about 350 cases with several deaths took place. When Dr. Thorne Thorne investigated the circumstances, one remarkable fact became evident—viz. that the disease was almost entirely confined to that part of the district supplied with the company's water pure and simple, whilst the outlying part, which was only partially supplied from the company's wells, but whose chief supply was from those of the neighbouring company, remained nearly free from disease. This fact, joined with the other, that the disease broke out just about the usual time after the workman must have been the cause of contaminating the well, pointed clearly to the Caterham Company's water as the medium of contagion. Another corrobo-

rating fact was, that at the Lunatic Asylum, where the water-supply was from a deep well on their own premises, the inmates remained free from the disease; and at the barracks, the Guards, who also drank the water of the Asylum well, did not suffer. The latter was a pure water, as I had an opportunity of analysing it myself. The remedial measures adopted were to stop the supply of water at once, to pump the wells dry several times, to scrape the sides of the wells and the adits and wash them with chloride of lime, and to throw large quantities of Condy's Fluid into the water. From that time the disease entirely ceased. No more marked proof could be given of the transmission of the disease through water.'

No more marked proof could be given of the enormous diffusion which takes place when typhoid poison is mixed with water, and of the dangers which necessarily attend upon water-carried sewage. If we foul the brooks, rivers, and wells which are about our houses we must rely on water companies for the first necessary of life, but if the common source gets poisoned we encounter epidemics of an extent unknown before.

The following case which is quoted (in German) in the sixth report of the Rivers Pollution Commissioners tells a similar tale; and it also tells us that typhoid poison cannot be removed from water by the most perfect underground filtration. The ensuing version of the 'Lausen case' is taken, however, from Mr. Noel Hartley's little book on 'Water, Air, and Disinfectants,' published by the Society for Promoting Christian Knowledge.

In the village of Lausen, near Basle, in Switzerland, which had never within the memory of man been visited by epidemic typhoid (enteric), and in which not even a single case had occurred for many years, there broke out in August 1882 an epidemic which simultaneously

attacked a large portion of the inhabitants. About a mile from Lausen, and separated from it by the mountainous ridge of the Stockhalden, which was probably an old moraine from the glacial epoch, lies a small parallel valley—the Fürlerthal. In an isolated farmhouse, situated in this valley, a farmer, who had just returned from a long journey, was attacked by typhoid fever on June 10. During the next two months three other cases occurred in the same house. The inhabitants of Lausen were entirely ignorant of what had occurred in this solitary mountain farm, which was cut off from all communication with the rest of the world; when on August 7 ten of the villagers were suddenly struck down by typhoid fever, whilst during the next nine days the number of cases had already increased to 57 out of a population of 780 persons living in 90 houses. In the first four weeks the number of cases reached 100 (that is to say, that out of every 100 persons in the village more than 12 were attacked); and altogether, to the close of the epidemic at the end of October, 130 persons, or 17 in every 100 of the population, were attacked, besides 14 children who were infected at Lausen during their summer holidays, and became ill after their return to school in other localities. The fever cases were pretty equally distributed throughout the entire village, but those houses (six in number) which were supplied with water from their own private wells, and not from the public fountains, were entirely exempt. This remarkable difference led to a suspicion that the public water-supply was connected with the cause of the epidemic, although the apparent immaculate source of this supply seemed to negative any such suspicion.

The water came from a spring situated at the foot of the adjacent Stockhalden ridge. It was then received

in a tank lined with brickwork and carefully protected from pollution: nevertheless, a careful investigation of the source of this spring placed beyond doubt the origin of the infection.

Ten years previously it had been proved that direct water communication through the intervening mountains existed between the spring and a brook in the Fürlerthal, flowing past the farmhouse in which the typhoid fever cases occurred. At that time (*i.e.* ten years before) there was spontaneously formed, by the giving way of the soil for a short distance below the farmhouse and close to the brook, a hole about 8 ft. deep and 3 ft. in diameter, at the bottom of which a moderately clear stream of water was observed to be flowing. As an experiment the whole of the brook water was now diverted into this hole, at the bottom of which it entirely disappeared, but in an hour or two the spring at Lausen, at that time nearly dry from a long drought, overflowed with an abundance of water which was turbid at first, but afterwards clear, and this overflow continued until the Fürler brook was again confined to its bed. It was, however, afterwards noticed that, whenever the meadows below this hole were irrigated with the water of the Fürler brook, the volume of the Lausen water-supply became greatly augmented a few hours afterwards. Now this irrigation, practised every year, was carried on in the summer of the epidemic from the middle to the end of July, the brook being polluted by the dejections of the typhoid patients—for it was in direct communication with the closets and dung-heaps of the infected house, whilst all the chamber-slops were emptied directly into it, and the dirty linen of the patients washed in it. Soon after the irrigation had begun the water-supply to Lausen, which was at first turbid, acquired an unpleasant taste, and increased in

volume. About three weeks after the commencement of the irrigation the sudden outbreak of typhoid fever in Lausen occurred.

In his search after the cause of this outbreak Dr. Hägler, of Basle, did not rest satisfied with the evidence just recorded, but supplemented it by the following ingenious and conclusive experiments: The hole in the Fürler was reopened and the brook again led into it; three hours later the fountains at Lausen delivered double the quantity of water.

'Eighteen hundredweight of salt, previously dissolved in water, was now poured into the hole, and soon the water at Lausen exhibited a great increase of saltness, until the solid matter in the water increased threefold. The passage of the Fürlerthal water to the fountains of the fever-stricken village was thus ascertained beyond doubt. But another interesting question here presented itself: Did the water find its way through the Stockhalden by a natural open conduit, or was it filtered through the porous material of the old moraine?'

'To decide this point 2½ tons of flour were first carefully and uniformly diffused in water, and then thrown into the hole; but neither an increase in the solid constituents nor the slightest turbidity of the Lausen water was observed after this addition.'

This remarkable case shows:—

1. That the power of mischief possessed by water-carried sewage is enormous.

2. That the diffusibility of typhoid poison in water is practically infinite.

3. That water containing typhoid poison may not be purified by filtration through nearly a mile of solid earth (a filter fine enough to arrest particles of wheat flour), although it must be borne in mind that the filter in this

instance was deeply buried, and that the certain absence of air and aerobic microbes rendered the oxidation and purification of the water passing through it an impossibility. The fact, also, that the Lausen water became *turbid* when the Fürler brook overflowed seems to indicate that, although the flour experiment gave a negative result, solid particles were, nevertheless, able to find their way through the Stockhalden ridge.

4. That large typhoid epidemics are favoured by a water-supply common to many people, if by mischance that water-supply gets fouled.

In the year 1893 the town of Worthing, a well-known seaside health-resort in Sussex, was reduced to a condition of temporary ruin by an epidemic of enteric (typhoid) fever. The epidemic affected Worthing, West Worthing, and the neighbouring villages of Broadwater and West Tarring; but for the sake of simplicity we will deal with the main outbreak at Worthing, the circumstances of which were investigated by Dr. Theodore Thomson on behalf of the Local Government Board. From Dr. Thomson's official report the following facts are culled:—

Between May and November 1,257 cases of enteric fever were notified in Worthing, the population of which at that time was 15,317. Of those attacked, 153, or rather more than 12 per cent., died. It must be borne in mind, however, that Worthing is a town to which persons pay short visits, and it is certain that many of those who contracted fever in Worthing were laid up with the disease elsewhere. The author certainly had two cases of enteric fever under his care at University College Hospital in 1893 for which the sanitary condition of Worthing was directly answerable. It is probable, therefore, that the number 1,257 is considerably short of the total cases.

The epidemic began towards the end of April, and was marked by two waves. The first part of the epidemic reached its climax towards the end of May, and had almost subsided by the middle of June. The total number of cases between April and June 23 was 296. At the beginning of July the disease burst out with redoubled energy, and reached a climax at the end of the third week in July, after which the cases notified got gradually less, and the disease finally disappeared in November. The total cases in the second half of the epidemic numbered 961.

Speaking of the general sanitary condition of the town, Dr. Thomson says: 'In not a few instances the open space round poor-class dwellings is somewhat scanty.' This condition of things is, as we have seen, the invariable concomitant of water-carried sewage.

The sewers were badly jointed, and wherever examined were found to be leaking. Some of them were laid on a dead-level, and two were reported to have a slight slope in the wrong direction. The sewers discharged into the sea, and during the periods of high tide (twice in every twenty-four hours) the contents of them were dammed back and unable to escape. The water-supply was from the municipal waterworks. The public supply commenced in 1857, when a well 68 feet deep, and with a bore-hole going for a further 300 feet, was sunk in the chalk. Ten years later, in 1867, a second similar well was sunk; and still further to increase the supply of water these two wells were, in 1880, united by a tunnel 72 feet below the surface. In 1885 it became necessary to sink a third well; but at a depth of only 18 feet a fissure was struck, and as the water supplied by this fissure was in large quantity and not considered to be good, the work was abandoned, and

recommenced some 70 feet to the south-west, and this well was united with one of the previous wells by a tunnel 72 feet below the surface.

In 1893 further supplies were called for, and accordingly a tunnel was driven from the bottom of the well sunk in 1885, in a north-easterly direction, towards the well which had been commenced and abandoned for the reasons stated in 1885. When this tunnel or heading had been driven to a length of 70 feet, and had reached a point just below the abandoned well of 1885, a fissure was struck which yielded 2,623 gallons per minute, and the men had to run for their lives. This occurred on April 12, 1893. The new water was at once used for the public supply, and within a few days the epidemic began.

This water afforded on chemical analysis very little reliable evidence of sewage contamination; but on bacterioscopic examination by Dr. Klein, the *Bacillus coli* was discovered, thus leaving no doubt that sewage had found its way into the wells.

By filling the abandoned well of 1885 with a ton of salt dissolved in water, the water in the new heading was rendered distinctly salt, and thus the direct connexion of this heading with the surface was demonstrated. On the north, west, and east of the Waterworks are sewers, the nearest of which, coming from the Infirmary, was only 160 feet from the new heading, and with a possibility of a backflow into a disused drain running still closer to the new heading. All these drains were found to be leaking.

The initial case of enteric fever which caused the first contamination was never traced; but it is no matter for surprise that, when the town was filled with cases of enteric fever, and the leaking drains were carry-

ing large amounts of poisonous excrement, which certainly found its way at one point into the well, the second wave of the epidemic was severe. In the Infirmary, the drain from which passed within 160 feet of the point where the fatal fissure was discovered, there were fifty cases of enteric fever in May, June, and July.

This epidemic is a striking example of the dangers of water-carried sewage. It shows that a leaking sewer is not a whit less dangerous than a cesspool. It shows also, that deep wells in the chalk are far from being absolutely safe sources of water-supply. It further shows that big waterworks, when contaminated, cause big epidemics, and it forces us to the conclusion that when we isolate patients suffering from enteric fever, it is also imperative to isolate their excreta.

In the face of recent events it is impossible not to regard it as probable that the 'initial case' might have been traced to an edible mollusc.

Medical literature is crowded with instances of mischief caused by water being contaminated by leakage from sewers and cesspools. The fact is so well established that it is not necessary to weary the reader with instances. The above cases show clearly (1) that one man has infected 350 others; and (2) that infections may travel for a mile through an *underground* filter.

In the face of the Lausen case it would almost seem that the absolute protection of a water-supply is nearly impossible.

Deep wells which are sunk in chalk or any other porous soil are liable to pollution from foulness finding its way into them from the surface or through cracks or fissures in the soil, and this danger is proportionate to the amount of water pumped from the well.

Messrs. Rogers Field and Wallace Peggs have, in an article in 'Our Homes,' given us the following instructive information:—

'Deep wells are much less liable to contamination than shallow wells, but even they are not safe from the insidious influence of cesspools. A very striking instance of this occurred at Liverpool some years ago in the case of the Dudlow Lane well, sunk in the New Red Sandstone formation. This well was situated in a suburban district some distance from Liverpool, and was 247 feet deep, with a bore-hole at the bottom another 196 feet deep, making 443 feet altogether. The effect of the continuous pumping from this well was to dry the wells of the houses in the neighbourhood, and these were then used in several cases by the householders as cesspools. The consequence was that the water in Dudlow Lane well was gradually polluted, and in five years after the well was constructed it had to be disused.'

Now the danger of contamination of deep wells is not due merely to their depth, but still more to the depression of the level of the water which is caused by the pumping.

'The distance to which the influence of pumping extends varies greatly in different cases, being in one case only fifteen times the depression, and in another as much as 160 times the depression. The chief circumstance which seems to influence the distance is the degree of permeability of the strata through which the water has to percolate. In fine sand and fine gravel, where there is a large amount of resistance to the passage of the water, the distance varies from fifteen to thirty-nine times the depression. In the chalk, where fissures exist which facilitate the passage of water, the distance is fifty-seven times the depression.'

Thus it appears that even the deepest wells may be fouled by cesspools, and if by cesspools, equally by leaking drains or sewers. And since we cannot know when a cesspool or a deeply buried sewer begins to leak, it is impossible to feel quite secure with regard to water-supply from deep wells in the chalk, which is just now the most popular source of water, and is being largely recommended. The danger of contamination from a distance is (in the case of chalk and other porous soils) proportional to the depth of the well, and also, in some degree, to the demand made upon the well for water; so that a public well may not prove dangerous until population has increased around it, and demands made upon the well have proportionately increased.

With regard to the pollution of wells, it must be pointed out (1) that such pollution is almost always from *underground* sewers or cesspools, the contents of which have had no chance of aeration and purification; (2) that such pollution is caused by *leakage*—*i.e.* the direct irruption of water from cesspools, &c., into wells without filtration of any kind; and (3) the sewage in sewers and cesspools, when it begins to leak, is under the pressure of a superincumbent column of water, and hence the burrows which it gradually forms extend long distances. The mechanical conditions of water thrown on the surface of the ground and water stored in underground tanks are entirely different—as different as are the biological conditions.

It is, we have seen, an easy matter to foul rivers, watercourses, and wells. How can water be purified when once fouled? There are porcelain filters in the market which seem capable of really sterilising fluids; but in the purification of sewage by what is known as intermittent downward filtration, it is now recognised

that the biological condition of the filter, *i.e.* the presence of a film rich in micro-organisms, is as important as its mechanical condition. This principle has been turned to account by the Massachusetts Board of Health, and is the basis of a system of 'treating' sewage devised by Mr. Scott-Moncrieff.

Boiling will probably destroy typhoid and similar poisons; but boiling for a short time only is, as is well known, not absolutely reliable.

Evaporation and recondensation is a sure method of purification. This is being done for us constantly by the sun, which evaporates the water which falls upon the earth, raises it in clouds, and gives it back to us again as rain. Nature is constantly engaged in purifying the water.

If we wish to have a constant supply of pure water near at hand, we must religiously abstain from careless water-pollution. Prevention is better than cure, and it is far easier to stop water-pollution than to remedy it.

In rural and semi-rural places water should never be used for carrying excrement; and building should be so controlled that water-carried excrement may not become necessary. Water fouled by domestic use should be thrown on the nearest available piece of ground. Some will be thus evaporated; some will be absorbed, together with much organic matter, by the roots of growing plants; and the rest will filter slowly through the earth, and find its way to a watercourse in a state of practical purity.

During the summer months, while vegetation is vigorous and the temperature high, scarcely any of the water will soak far away, but all will be evaporated and absorbed by the roots of the plants. Trees and vegetables, be it observed, are the best, and really the only

effectual, scavengers. They also suck the water from the soil and keep it dry. It has been estimated by Pettenkofer that an oak-tree with 711,592 leaves will, during the summer, evaporate $8\frac{1}{3}$ times the amount of rain falling on the ground which it covers. The *Eucalyptus globulus* will evaporate eleven times the rainfall. We should always expose waste water to the air and to alternations of temperature; the heat or the east wind will dry it up and stop the growth of organisms; cold will freeze it, and equally stop the growth of organisms. In sewers and cesspools there is neither heat nor cold, summer nor winter. In that muggy, damp atmosphere, evaporation and oxygenation are impossible. And waste water, after travelling miles of pipes, is not appreciably diminished in volume, and is charged in addition with whatever of impurity it may have met with in its dark journey.

From what has been said it will be gathered that cesspools ought not, *in any circumstances*, to be permitted. If they be mere holes dug in a porous soil, their contents may soak nobody knows where; if they be impermeable, they are still hotbeds of filth-disease, and give off the gases of putrefaction which affect those in the neighbourhood.

There is all the difference imaginable between a cesspool and an old-fashioned privy. The latter was more or less open, but little liquid found its way into it, and evaporation rendered the contents so solid that soakage and leakage were, if not impossible, at least difficult of occurrence.

A cesspool receives water, and its contents *must* soak away, diffusing poison through the earth. The constant pouring of liquid slops into the same hole day by day is sure to cause cracks and fissures in the soil, and the

pressure of water is sure to force an outlet, often where least suspected.

Cesspools must be written down as the most immoral of all sanitary subterfuges, and their construction should be absolutely disallowed. Excrement should never be allowed to come into contact with water. Open channels are better than closed pipes for the escape of waste water from houses.

Closed sewers should only be resorted to in case of the direst necessity and with a full sense of their danger. And solid excrements (which are often dangerous poisons) should be kept out of them, lest the diffusions of excrement poison become co-extensive with the sewer.

Under existing conditions surface wells are not safe sources for water. A well of moderate depth, protected from surface drainage and in the middle of a well-cultivated plot of ground, would be a safe source for water if no cesspools existed. Surface wells in towns, the soil of which is excrement-sodden, are little better than cesspools, and they are highly dangerous. The most dangerous surface wells of all are probably those in big towns like London, where, owing to the gas in the earth and the sulphur in the air, vegetation is at its minimum.

In a rural town, standing almost in the water-meadows on the banks of a river, the suggestion had been made that the town should be sewered in order that the level of the subsoil water should be lowered. The following are the remarks on this point which were made by the author to the sanitary authority which consulted him :—

'This (the lowering of the subsoil water) is doubtless desirable, but to effect it, it would be necessary to lower the level of the river. Whether this be possible I cannot

undertake to say. There may be some local mill or dam (of which, however, I could see or hear nothing) which might be removable at a reasonable cost.

'Possibly there may be those who think that a system of sewers would help to lower the level of the subsoil water.

'The following considerations lead me to think that such a result would be very unlikely:—

'1. A system of sewers would act as land-drains, and would facilitate the descent of the subsoil water from the higher parts to the lower.

'2. A system of sewers (and water-closets) would necessitate the "laying on" of water to every house, and, assuming that the sewers did not leak, they would be filled with water from the Waterworks—water which is obtained from a deep well sunk to a water-bearing stratum far below and distinct from the superficial water-bearing stratum. A supply of pure water such as that supplied by the water company is a great boon, but we must not lose sight of the fact that to pump water from the depths of the earth on to a district already overburdened with water, and at the same time to give up pumping water from the surface wells, is more likely to augment, than otherwise, the amount of water circulating in the subsoil. If the sewers did not leak the sewage pumps would, at the most, remove the additional water which had previously been artificially pumped into the district for flushing purposes.

'But if sewers were laid in the low-lying, water-logged districts, they would (judging by experience elsewhere) be certain to leak sooner or later; the sewers would fill with subsoil water, and the amount of liquid sewage would be so enormous as to prove unmanageable. I am, therefore, strongly of opinion that, if at any future

time a system of sewers is provided for the district, the low-lying, water-logged portions of the district should, for the reasons given, be excluded.'

The idea seems general that it is impossible to supply too much water for the daily use of households. This is very questionable. Enough is as good as a feast. No very large amount of water is needed for the attainment of absolute cleanliness, both personal and domestic. The man who is minded to be clean will attain his end with a small amount of water; and even though we take a river to those who love dirt, they will make no use of it.

It is certainly not advisable to dirty more water than is necessary, because by law the water must be purified again before it returns to the river, and this entails endless expense on sanitary authorities.

If those who rely on public bodies for their water-supply are made to pay for exactly as much as they use, we may be sure that no excessive waste will take place, and there is but little fear that the price will be such as to prevent even the poorest from having enough.

The objection which is raised to the supplying of water by meter is, that in such circumstances the poor would be insufficiently supplied. It would be easy, however, to adopt a sliding scale of charges, giving the water of necessity at a low rate, and charging more for the water of luxury. If sixpence per thousand gallons were charged for the first ten gallons per head per diem, this would amount to 1*s.* 9*d.* per head per annum. A shilling per thousand might be charged for the next five gallons per head per diem, and 1*s.* 6*d.* for the next five gallons, and so on.

Construction of Wells

It is admitted that humus is one of the best filtering materials for water, and that water from a river full of living organisms is to a large extent freed from them by filtering through a few feet of the humus on its banks. The late Sir E. Frankland showed that water of singular microbial purity could be obtained from the gravel beds which in places flank the Thames. Such water, one must suppose, is obtained from ground water which has fallen upon the earth, has filtered through it, and is slowly flowing towards the river. The purifying agent in these cases is mainly the living humus which lies upon the surface, although the subsoil cannot be without some effect. These facts must alter our attitude towards surface wells, and must teach us what to a great extent has been admitted—that the purity of surface wells must depend more upon the mode of construction and the surroundings of the well than upon its depth. Wells are polluted by foulness which has reached the subsoil without being subjected to the purifying influence of the humus; and there are many facts which go to show that if foul water gets to the under side of the humus without going through it its purification in the subsoil is far from certain. The Lausen epidemic, the Worthing epidemic, and the pollution of the deep well sunk in the sandstone at Liverpool, seem to show us that percolation through a mile of underground strata entails no certain purification, and that wells 80 ft. or 400 ft. deep are not safe if fissures allow the contents of cesspools, leaking under pressure, to trickle into them. The almost universal condemnation of surface wells and their frequent pollution are mainly due to the fact that we take our filthy and dangerous liquids through the

humus in pipes, and thus ensure at great expense that they cannot be subjected to purification by it. If these underground pipes leak, the mischief caused by pollution of wells may be very far-reaching. It is very probable that foul water continuously thrown on the same spot of ground may in time work its way to a well and thus pollute it. Such ground, which is constantly soaked, be it remembered, is never tilled, because tillage is impossible. For ground to be tillable it is essential that reasonable breathing-time should be allowed. I am not altogether sure (although I hardly dare utter such a heresy) that a properly constructed surface well in a selected situation may not prove to be one of the safest sources for water, because it can be inspected with perfect ease, and the fact of accidental leakage into it would become apparent. In this connexion it may be well to describe in full detail the well which I have sunk in my garden at Andover, a garden which is rather handsomely manured with human excreta. The well is placed in the very centre of the garden (see figs. 9, 10, p. 264) at the intersection of two paths—a broad green path and a narrow asphalted path. This situation was chosen for two reasons: (1) that it was as far as possible removed from any accidental pollution from the sewer in the street; and (2) that in the centre of the garden it would theoretically run the greatest chance of fæcal contamination from the manure used. As the well was sunk solely for experimental purposes this was essential. The garden is on a river-bank and very slightly raised above the level of the water. The well is only some 5 ft. deep, and the water stands at a level (which varies very slightly) of about 3 ft. 6 in. from the bottom. The well is lined throughout from the very bottom to a point some 15 in. above the ground with large concrete sewer-

pipes 2 ft. 3 in. in diameter, and these pipes have been carefully cemented at their junctions. Outside the pipes a circle of cement concrete about 4 in. thick has been run in. It will thus be evident, the sides being perfectly

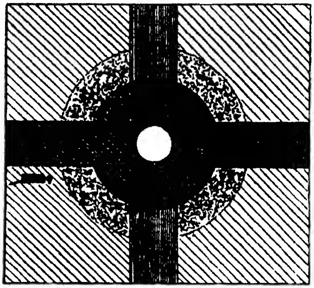


FIG. 9.—PLAN OF WELL, SHOWING ITS RELATION TO PATHS AND HEDGE.

protected, that no water can possibly enter this well except through the bottom, all contamination by lateral soakage through the walls being rendered impossible. The well is surrounded by an asphalte path about 3 ft. wide and slightly sloping away from it, and it is encircled

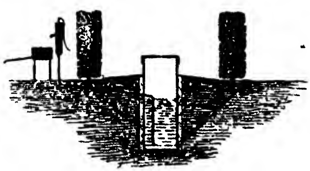


FIG. 10.—SECTION OF WELL, SHOWING CONCRETE LINING AND POSITION OF PUMP.

by a clipped privet hedge about 5 ft. high, except at those points where the circle of privet is cut by the paths. There is a closely fitting cover of oak, which has an outer casing of lead, and thus all contamination from above is prevented. The water is drawn off through a

2-in. leaden pipe which passes through the outer concrete and the concrete lining pipe, the cut passage for the pipe being carefully closed with cement. The pump is behind the privet hedge, and is provided with a sink and waste pipe which takes the overflow some twenty or thirty yards to a neighbouring stream. In this way the constant dripping of water in the neighbourhood of the well is prevented; for I am very much alive to the dangers attending a constant water-drip, which might be able in time to worm its way through soil and concrete into the well itself. I regard this question of the overflow as one of great importance which is too often neglected. Figs. 9 and 10 show this well in section and plan. The nearest point to the well upon which any manurial deposit of excreta is likely to be made is on the far side of the privet hedge, and the distance of this point from the bottom of the well is 7 ft. All water which finds its way into the well must have passed through at least 6 ft. or 7 ft. of earth, and, of course, the great bulk of the water has passed through a far greater length. Three chemical analyses of this water, one by the late Professor Frankland and two by Dr. Kenwood, testify to its organic purity, and three bacteriological investigations have given similar indications of purity. A bacteriological examination of the water from the river Anton and the well water, made on April 11, 1895, gave 1,133 growths per cubic centimetre for the river and only 7·5 for the well. Of course there may be a dangerous microbe among this small number, but, on the whole, I think the best guarantee of the purity of the water is the condition of the well, which after four years is as clean on the bottom and sides as it was the day it was made. There has been no appreciable increase of sediment on the bottom, and the pebbles are as

plainly visible as they ever were. The well is for experimental purposes mainly, but water for garden use is drawn from it, and during the severe frost of 1895–6 my gardener and some of his neighbours were entirely dependent upon it for household purposes. I seldom go into my garden without drinking some of the water, which is clear and delicious, and my visitors seldom escape without drinking some also. I think the well is a very safe one.

It must be mentioned, however, that after very excessive amounts of rain, such as occur occasionally, when the water comes down in a perfect deluge and lies for hours in big pools upon the ground, the water in the well becomes turbid. My belief is that under these circumstances the fine sediment on the bottom is driven upwards by the suddenly increased pressure of the water outside; and I have no reason to think that after these storms there has been any actual increase of sediment, the stones at the bottom remaining as visible as ever. I have never been able to make a bacteriological examination after one of these floods, but hope to be able to do so.

The question whether such a very shallow well becomes dangerous after a flood is a most important one. It is clearly understood that with my well there is no possibility of flood water entering at any point except through the bottom. It must be recognised that in times of flood with a drowned humus the power of purification may be lessened. On the other hand, my experience leads me to say that it is very difficult (if it be possible at all) to wash fæces out of well-tilled humus by any rain which we get in this country. In the autumn of 1894, in the south of England, we had very severe floods, and I was able to note that the humifica-

tion of fæces in my garden was, as a consequence, very much delayed. Fæcal matter was visible on turning up the soil for nearly three months after it had been deposited, and the masses of fæcal matter were enclosed in crusts of humus which had been rendered airless and claylike by the excessive amount of water. This naked-eye test seemed to show that the well had not been endangered, for there were the fæces, and most certainly they had not been washed downwards. When the pores of the soil had been opened by frost the humification of the fæcal matter went forward as usual. This experience seems to enforce what I have said before—that a drowned humus cannot deal with dung. That floods may be dangerous to surface wells we all know, but it will be recognised that the conditions and circumstances of my well at Andover are distinctly different from those of the wells mentioned in the following extract, which were filled with flood water by leakage through their tops and sides.

In the Twenty-third Annual Report of the Local Government Board (1893–94) reference is made by Dr. Thorne Thorne to certain investigations on outbreaks of typhoid fever in certain riverside populations in Yorkshire and Lincolnshire. These investigations by Dr. Bruce Low seem to prove conclusively that the fæcally polluted water of the Rye and the Trent had infected with typhoid fever a certain proportion of the inhabitants who consumed the raw river water. Dr. Thorne Thorne goes on to say: 'Incidentally it transpired during the course of this inquiry that the town of Malton had an altogether exceptional history in so far as enteric fever and diarrhœa in fatal form are concerned. Situated on the Derwent, four miles below the confluence of the Rye with that river, Malton was found to derive its water-supply from the

Lady Well, sunk to a depth of 14 feet in the middle oolite rock, and occupying some low-lying land close to the river bank. Into this well river-water gained access as soon as the Derwent rose above a given point, the amount of river-water reaching the well varying from mere leakage through holes and crevices in the banks to complete submersion of the Lady Well by the swollen stream. Gradually it had come to be noted that the outbreaks of fever and of diarrhœa followed on seasons of flood in the Derwent, a river which was referred to locally in 1890 as containing 'the sewage of all the towns and villages situated near the Rye and its numerous tributaries.'

In country places where surface wells are the only available source of water, I strongly recommend that they be made on the pattern which I have been describing.

It is the top of the soil which can break up and assimilate organic matter; the subsoil has no such power. It is a common mistake to bury deeply any organic matter which seems to us to be particularly offensive. In this way we ensure its preservation and endanger the wells. The safety of our wells is directly proportionate to the thickness of the humus, and to place organic matter below the humus is like throwing the dog's bone beneath the kennel instead of into it. The inefficiency of deep burial hardly requires to be mentioned. Bodies buried deep in the subsoil last for years, while those which are placed in the living humus are rapidly destroyed.

I should like to mention that when my well was dug there was found beneath a turf path and about three feet below the surface a large quantity of dead leaves which had probably been deposited in a pit at some long antecedent date. They had undergone scarcely any decomposition although they had been in that position very many years. Again, when engaged in pulling down a cottage

my man unearthed an old privy some four feet below the surface. In this privy unmistakable fæcal matter was recognisable. Neither he nor I nor any of the neighbours had any knowledge of any such privy having been in use of late years, and my belief is that these recognisable excreta had been deposited at least half a century ago. Who shall say that these excreta did not still contain spores of all the ills that flesh is heir to? Under natural conditions all dead organic matter falls upon the surface of the ground, and nature is a very sure guide.

As country places are very apt to follow the fashion set by large mercantile towns, it may not be amiss to recount the history of some country waterworks.

In the year 1876 some of the more enterprising inhabitants of a country town of about six thousand inhabitants formed a water company, and in the year 1890 the waterworks of this company were purchased by the municipality.

From the report of the last annual meeting of the water company, held on March 19, 1890, it appears that the capital of the company consisted of 4,000*l.* in ordinary shares, and 3,000*l.* debentures, bearing interest at 4½ per cent. The report of the directors showed (1) that the capital had all been expended; (2) that new works necessitating fresh capital were necessary; (3) that on the 'suspense account' there was a deficit of 60*l.*, while on the revenue account there was a profit of 288*l.* after paying debenture interest. They recommended a dividend at the rate of 6½ per cent., which would absorb 260*l.*, but the balance of 28*l.* would still leave them with a deficit of 32*l.*

Having started the year with a balance (after paying 5 per cent.) of 56*l.*, they left off with a deficit of 32*l.*, or 88*l.* less than that with which they started. Had

they been content with a dividend of 5 per cent. they would have carried 28*l.* forward as a balance, after paying the 60*l.* deficit. Had they paid 4½ they would have started the new financial year only a few pounds worse than they had begun the old one. The question of the purchase of the works by the Corporation was 'in the air,' and it was discussed at their annual meeting. Indeed, it is not improbable that the opinion generally expressed in the street, 'that the Corporation was bound to purchase,' may not have been without influence in causing a bias towards the somewhat thriftless conduct of beginning the new year with a minus quantity, and this in the face of increased outlay in the near future. It may be stated that in this final year the receipts from water charges had reached 721*l.* (of which the Corporation had paid 100*l.* for street-watering), and that the payments for salaries, fees, and wages had been 135*l.* 1*s.*

The story is a short one; the Corporation, 'possessed' by the notion that they must purchase, opened negotiations, and called in an expert to value the property. This expert (an engineer) advised the Corporation in the first instance to give 7,500*l.*, a sum sufficient to pay off the debenture-holders and give the ordinary shareholders a bonus of 12½ per cent. After this first advice had been tendered, it was found that the supply of water was better than had been expected and that the short supply was in a measure due to leaky pipes. The expert on being informed of this advised that 8,500*l.* should be given, but at the same time warned the Corporation that no inconsiderable sum would be necessary to provide increased engine-power, &c. The water company stood out, and in the end the Corporation gave 9,500*l.*, *i.e.* 8,000*l.* for the debentures

and 6,500*l.* for the ordinary shares, which they thus bought at a premium of 62½ per cent. The purchase was completed in November 1890.

To bring the story down we must appeal to the Corporation accounts for the eighteen months ended March 23, 1893.

From this it appears that the water charges for these eighteen months had reached 1,190*l.* 5*s.* 4*d.*, while the expenses (of which 726*l.* was for interest on loans and 205*l.* for salaries) had reached 1,235*l.*, leaving a deficit on the first eighteen months' working of 45*l.*

From the loan account it appears that the debenture-holders had not been paid off, but were still getting their 4½ per cent. from the Corporation; that the legal and other charges for transferring the works had been 156*l.*, and that additions to the plant had been nearly 290*l.*

On August 10, 1894, the question of the water works came before the Town Council, and upon a demand of 150*l.* for twelve months to meet various claims a councillor remarked that 'he was taken by surprise that so much money should be asked after the rosy account given of the works by the Chairman of Committee at the previous meeting. He was told by the Treasurer that their income instead of increasing was decreasing, which was a serious matter. . . . He thought they should see to it, for as far as he could see from the figures supplied, unless they got a considerable increase of revenue this would be a yearly charge on the rates, and if certain contingencies arose the charge would be still more.'

The Corporation had presumably bought these works as a 'going concern,' paying 6½ per cent., and since the purchase they had worked them at a loss, which cost the ratepayers in the last year 150*l.*

From a review of this transaction, there can be no doubt that the directors of the company were much better men of business than the Town Councillors, and it is hard to understand the modern craze for universal municipalism, which bids fair to be an expensive craze for ratepayers.

One of the functions of a sanitary authority is to protect the public from the rapacity of public companies; and one would fear that the desire to make money out of the needs of the inhabitants must hamper the judgment and impartiality of the authority. This fashion of sanitary authorities to become purveyors must be regarded as an interesting socialistic experiment, but not one which is likely to conduce to the public health or public convenience.

From the municipal accounts for the year ended March 25, 1902, we learn that the receipts from water charges amounted to 645*l.* 16*s.* 7*d.* These lessened receipts, in spite of a considerable increase of population, are due to a lowering of the water-rate and the dropping out of the account of 100*l.* paid by the corporation for street-watering. Against these receipts we have expenditure as follows:—

	£	s.	d.
Interest and repayment of loans	635	1	11
Salaries	71	14	10
Wages	170	8	5
Coal	180	1	4
Gas	20	15	0
Rates, taxes, insurance	46	10	6
Stationery	2	11	0
	1,127	3	0

In addition there is expenditure under 'miscellaneous' of 1,117*l.* 9*s.* 4*d.* In this account there is no attempt to keep current expenditure distinct from capital

expenditure, and it includes 529*l.* 11*s.* 6*d.* for land and transfer, 510*l.* 15*s.* 1*d.* to local tradesmen for pipes, &c., and 77*l.* 2*s.* 9*d.* for repairs and sundries. This last sum must be regarded as current expenditure, and brings the total to 1,204*l.* 5*s.* 9*d.*

Thus it appears that the ratepayers, in their capacity of water purveyors, lost at least 558*l.* 9*s.* 2*d.* in the year, and be it remembered that there was fresh borrowing on account of water amounting to 362*l.* 7*s.* 2*d.* within the year; so that the charges for interest tend to increase.

In the face of these facts the water rate has been lowered from 8*d.* to 6*d.*, a reduction of 2*d.* From the municipal accounts it appears that a rate of a penny brings in exactly 100*l.*, from which one may infer that the rateable value of the borough is 24,000*l.*

It appears, therefore, that to compensate for the twopence dropped into one pocket fivepence halfpenny has to be taken out of the other.

There are big ratepayers who are, and who are likely to be, dependent upon their own wells. Some of these live three or four miles outside the area of the municipal waterworks, but they have to pay.

CHAPTER VIII

PRACTICAL DETAILS

THE writer may fairly claim to have had considerable experience in practical sanitation. For thirteen years he acted as honorary secretary, and subsequently as vice-chairman, to the Parkes Museum of Hygiene, and he is bound to admit that it was in the course of listening to many lectures by several persons at this useful institution that he became impressed with the fact that the dangers of water-carried sewage more than counterbalanced its advantages, and that it is not the interested patentee who is to be regarded as the herald of the Sanitary Millennium.

In the course of professional work, both in hospital and private practice, scarcely a day passes that he is not confronted with 'filth disease' in one form or another requiring investigation as to causation; and, further, he has had experience of practical sanitation as a citizen in three distinct places, viz. (1) in London, where he has lived for more than twenty years; (2) in a country town, where, as a small owner of houses and cottages, the sanitary question has presented itself in aspects such as are common in semi-rural districts; and (3) in a village ten miles from London, where he has occupied for eight years a 'suburban villa' of the commonest type, and has practically studied the question of the sanitation of a growing suburb.

In order that the dwelling and its surroundings may be wholesome, it is essential that all excremental and putrescible refuse be removed *every day*. To allow such stuff to accumulate for a week before removal, as is done in some places where what is known as the 'pail system' is in vogue, is quite indefensible, and I believe that a daily removal would be found easier of accomplishment than a weekly removal. The vessels used for this purpose by municipalities are often absurdly heavy, cumbrous, and expensive, and, *even when empty*, are more than one man can easily move, and such as to require a cart of special and peculiar construction for their transport.

With a daily removal the vessels should be cheaper and lighter—mere galvanised buckets with lids—and of such a size that one man can carry two of them when charged with their daily quota. In this way the initial cost and the cost of dragging the dead-weight of the expensive two-man pails are saved, and the pails can be moved and shifted at least four times as quickly when two can be lifted by one man than when one requires two men to lift it; and when we take into consideration the fact that a man working alone has never to wait for his mate, it is tolerably clear that daily collection is economically equal to, and sanitarily vastly superior to, a weekly collection.

But, the stuff being collected, what is to be done with it? To this question there is only one answer. It must be buried immediately, and the nearer the ground is to the houses which provide the refuse the greater will be the economic success of the undertaking. As soon as the material has been put beneath the surface of the ground it is safe; it can neither pollute air nor water, so that the greater the proximity of the burial-ground to

the houses, the better. It follows as a necessity that ground used for the burial of excremental and putrescible refuse *must* be cultivated; but in this there can be no difficulty, because such ground will produce all garden crops in the greatest perfection—fruit, flowers, vegetables. There is no reason whatever why public gardens and the trees planted by the side of streets should not receive their quota of putrescible matter. If applied with care and knowledge it can do *nothing but good.* It needs hardly to be said that *no antiseptic of any kind* must be mixed with the refuse before it is put in the ground. *All antiseptics, whether they be mineral salts or tar products, render the ground sterile,* and it is certain that no practical gardener would willingly run any risk of allowing antiseptic bodies to come into contact with the roots of his plants. It may be taken as an axiom, that where antiseptics are necessary the hygienic arrangements are bad and incomplete; and it may further be taken as an axiom, that when antiseptics have been added to sewage matters in sufficient quantity to kill the microbes in the sewage and to arrest putrefaction, such sewage has no longer any manurial value, but, on the contrary, is a source of great danger to the agriculturist. Fortunately for the sewage-farmer, the methods of 'treating' sewage with antiseptics need not always be taken seriously.

Town sewage is necessarily of most uncertain composition, containing as it does not merely putrescible matter which is good for the soil, but trade refuse (strong acids, alkalies, and the like) and an abundance of antiseptics (which are always largely used, both by public authorities and private persons, wherever water-carried sewage is in vogue), which, applied to the soil, can only produce results of the most woeful kind.

Each variety of refuse needs its own peculiar and suit-

able treatment. To mix domestic refuse and manufacturing refuse, and to imagine that any *one* method of treatment will satisfactorily purify the mixture, is absurd. As a matter of fact, this indiscriminate mixing destroys the value of the whole of it.

It must be borne in mind that, in all our arrangements for dealing with organic refuse, our aim must be nitrification, and not putrefaction. The key to success is free exposure to the air.

Although the knowledge that nitrification is caused by a microbe is a recent acquisition, the practical conditions which favour the production of nitrates have long been known. The following passage from a paper by Dr. J. M. H. Munro in the 'Journal of the Royal Agricultural Society' for December 1891 puts the whole matter very plainly :—

'Boussingault, the pioneer of the experimental method in agricultural science, was well aware of the importance of nitrates and of the reason of it, one of his earliest essays bearing the title, "On the Influence of Saltpetre on the Development of Plants." As early as 1856 he had succeeded in devising a method for estimating the nitrate present in soils, and he gives us the result of testing over thirty samples. He found the nitrate in traces only, or in very small quantities, in some forest and meadow soils and soils with growing corps; in very small quantity after very wet weather in autumn, and immediately after the growth of a crop; in larger quantities in fallow soils in a dry autumn, and in largest quantities after a long spell of dry weather during the summer. In one case he gives under two parts of nitrate per million in the soil of a hop field in September after heavy rains, six hundred parts per million in the same soil in the following July after a long spell of dry weather,

and thirty-three parts again the following October. Whether his figures are strictly accurate or not, the great fluctuation in this floating capital of the soil was evidently quite familiar to him, and subsequent observers have but confirmed the general tenor of his results. Greedily absorbed from the soil by a growing crop, easily washed out of it by the winter's rains, and *accumulating or being formed in the soil* during warm and not too dry weather, and especially in fallows—these were obviously the main determining circumstances of the fluctuations.

'It is only natural that the mode of formation of such a valuable substance should be an interesting and promising field of inquiry. To the natural process of *nitrification*, as it occurs in the nitre-producing villages of India, Europe has been, and still is, largely indebted for a supply of nitrate of potash wherewith to make gunpowder. The heaps of nitre-earth found near the sites of former habitations consist of house refuse mixed with porous soil, ashes from the fires, urine, &c. After long-continued exposure to Indian warmth, lixiviation of this nitre-earth with water furnishes a solution from which saltpetre is extracted by evaporation and crystallisation.

'In 1777, when France could not import saltpetre, the Government caused to be printed "Instructions for the Establishment of Nitre-heaps," which Boussingault makes the subject of one of his essays, and his observations and drawings make it plain that before his time the practical conditions of nitrification were well known. Heaps of soil mixed with ashes and animal refuse, arranged in layers separated by loose straw kept under cover, freely exposed to air, and watered as often as possible with urine, turned and removed once or twice if practicable, furnished in the course of some months a notable supply of nitre. If treated after the manner prescribed, we learn that

about 450 tons of material would in two years furnish about 4½ tons of crude saltpetre. The watering with urine was to be stopped some months before the final lixiviation. Though earth was regarded as a purely mechanical agent, and any earth not too compact would serve, the best was known to be *that already charged with nitrate*, such as cave earth, manured garden soil, the earth in the neighbourhood of stables and refuse heaps, &c. The necessary potash of course came from the ashes, the oxygen from the atmosphere, and the nitrogen in Boussingault's time was known to be supplied by the urine and animal matter, and to be converted by the putrefaction of these into ammonia before undergoing oxidation and combination with the potash to form nitrate.

'For the potash of the ashes substitute the lime of the soil, and for the nitrogen of the animal matter that of the decaying vegetable matter of the soil, which is slowly given off as ammonia during the decay, and it is seen that the formation of nitrate of lime in soil proceeds on the same lines as that of saltpetre in the nitre-heap. That the formation of nitrate is encouraged by warmth, by moisture, by porosity of the soil, by tillage and other operations favouring free admission of air, and by the presence of lime and potash, was as well known fifty years ago as it is to-day. But the combination of the atmospheric oxygen with the nitrogen and hydrogen of the ammonia resulting from decaying vegetation was then, and for many years afterwards, supposed to be as purely chemical an action as the combination of nitric acid, once formed, with lime or potash to produce nitrate of lime or nitrate of potash.'

When excremental matters are buried they must not be buried deeply. The end we wish to obtain is nitrification, not putrefaction; and to this end oxygen and

microbes are both necessary. Theoretically, perhaps, the best course would be to allow them to remain upon the surface, for we know that such matters, when left on the surface of the ground, quickly cease to be offensive to our senses. Practically, the best course is to bury them immediately beneath the surface, one spit or half a spit being amply deep enough. To bury such matters deeply is to court failure and endanger the water-supply.

When 'earth-closets' are in use there are certain practical points which demand attention. In the construction of an E.C. every attention should be paid to cleanliness and decency and their easy maintenance. An E.C. should never be contained within the four walls of the main structure of a house. It should either be a distinct building or should be approached by a verandah or short passage or corridor with cross ventilation.

If possible, it should be lighted from the top. In one which was built for the writer the roof is composed entirely of semi-opaque glass, and thus the least impurity is at once noticed. The floor must be of concrete or tiles. The receptacle beneath the seat should be of galvanised iron, and may be removed from the front or by a special opening in the back or sides. Guides must be placed upon the floor beneath the seat, in order to ensure that the pail is always placed accurately in the same spot. The seat should be of mahogany or some equally hard wood polished, the walls should be matchboarded and varnished, and thorough ventilation should be provided.

The earth should be stored in a bin alongside the seat, and should be thrown upon the dejection by means of a scoop, such as is used for flour or sugar. The various mechanical contrivances for precipitating the earth are too

accurate. When they are used the earth falls away upon exactly the same spot, whereas the dejecta do not. To attempt in the E.C. to imitate the mechanical details of the W.C. seems to be a mere silliness. If a scoop be used, and if the earth be stored in a bin, the emptiness of the bin and the absence of earth are at once evident on entering the closet, and there is less likelihood of the necessary replenishments being forgotten. *The earth must on no account be artificially dried over a stove.* If this be done there is great risk of sterilising the earth and stopping that microbial interaction between the earth and the fæces which is the main thing to be encouraged. In the same way the unnecessary and expensive use of heat in manufacturing 'Poudrette' serves to diminish the manurial value of fæcal matter submitted to this process. If the earth be sifted and stored in a shed for a few weeks before it is wanted it will be quite dry enough, and it is most important for comfort that the earth should not be so dry as to raise a powdery dust when it is thrown into the pan. A small quantity of ash may be mixed with the earth, but always in quantity short of that which raises a cloud of powdery dust. Ash, be it remembered, is sterile, and although it has a useful effect in drying the dejecta and providing bases for combining with nitric acid, it tends, if used in too great a quantity, to check rather than encourage microbial action. When patent hoppers are used for shooting on the earth, the drier and more powdery the earth is, so much the better for the patent hopper, but so much the worse for microbial action.

An earth-closet should always be provided with a brush (of the kind known as a 'kitchen hearth-brush'), in order to sweep away any crumbs of earth which may be spilled accidentally. An earth-closet should be emptied

every day, and the contents should be placed in a shallow trench and lightly covered.

If earth be scarce, the contents may be placed in a heap in an open shed, in which case the microbial action will soon reduce the whole to the condition of garden earth or humus. This humus may be used again and again, and the microbial activity, and its power of changing fæcal matter to humus, will suffer no loss whatever, but will rather tend to increase by a multiplication of the microbes. The bulk of the earth which is used in this way tends to increase, but the manurial value of a given weight does not tend to increase after a certain point has been reached.

Because closet-earth has been found by chemists to contain less nitrogen than pure Peruvian guano or nitrate of soda, it has been said that it has small manurial value, but those who say so form their opinions on theoretical grounds, and not from practical experience. The writer has now had twenty years' experience, and his belief is that closet-earth is as fertile as it is possible for earth to be, and if used with common agricultural skill and knowledge is capable of producing all garden crops—fruit, flowers, vegetables—in high perfection. It is not, of course, comparable in any way to the artificial stimulants so much in vogue with agriculturists, and only an ignorant person would make any comparison between them. Chemical manures can only be used in a state of extreme dilution, and if used too strong may cause incalculable mischief. In the same way 'night-soil,' which consists of partially dried excrement and urine, and is more comparable to guano than to closet-earth, is sometimes dangerous from its strength, and requires to be used with caution. Closet-earth, when ripe, is *earth*, not manure. It is simply the richest earth possible,

incapable probably of further enriching, but equally incapable of doing mischief by its strength.

The estimation of nitrogen does not tell us all that we want to know about a manure. Our ignorance concerning the causes of fertility and sterility of soils is still very great. The recent discovery that the fertility of the soil for certain leguminous plants depends not upon anything which the chemist can detect, but upon the presence of microbes (almost invisible to the highest powers of the microscope, absolutely imponderable in the most delicate balance), which grow as parasites on the roots of the plants, and play an indispensable part in their nourishment, must force upon us the conclusion that, useful as chemistry has been to the agriculturist, it cannot tell us all that we require to know concerning the causes of fertility or sterility.

Speaking with twenty years' experience, I have no hesitation in stating my belief that for horticultural purposes closet-earth is unsurpassed. The garden where my experiments have been made is in a low-lying situation near a stream, and the only fault which I have to find with it is that the crops have a tendency to be gross and too luxuriant. The cause of this fertility is not to be attributed solely to the nitrates in the closet-earth, but it is quite conceivable that some of the microbes, which we know swarm in the intestines of man, may play an important part in the change which excremental matters undergo in the soil, and in the interchange between the soil and the rootlets.

That organic manures ('farmyard manure') are superior to all artificial manures is now generally acknowledged, but farmers are apt to complain that they 'foul the land'—*i.e.* that the undigested seeds of weeds, grasses, and forage plants which the animals have con-

sumed are liable to germinate and choke to a greater or less extent the crop which is being cultivated.

Man, however, is a 'cooking animal,' and therefore very few vegetable seeds are liable to pass through his intestines and still remain capable of germinating. Closet-earth produces very few weeds, although there appear upon ground where it is used seedlings of gooseberries, currants, strawberries, and raspberries, and of any other fruit which is habitually consumed without being previously cooked. If these seedlings be preserved, some of them will be found exceedingly prolific.

The best kind of earth to use with an E.C. is undoubtedly garden mould or humus, and the richer the earth is and the fuller it is of microbes, the more quickly will all be changed to earth. If earth taken from a considerable depth be used it is sure to be comparatively sterile, and the change is slow; or again, if ashes, which, of course, are absolutely sterile, be used in large quantities, or if the earth have been accidentally sterilised by overheating, the action may be very much delayed. Again, the temperature and humidity of the air are all-important in their relation to the interchanges between the earth and the organic refuse. It is quickest in ordinary summer weather, when sunshine alternates with showers, and it is checked to a greater or less extent by cold and also by drought, for without a certain degree of moisture the nitrifying microbes fail to grow. I think one would be justified in saying that in ordinary summer weather the humification of excreta is accomplished in about three weeks, but that in unfavourable weather (cold or drought) it may be delayed to a degree proportionate to the length of the unfavourable conditions. When what I have called 'humification' is complete, all has been turned to humus with an earthy smell and without any

offensive qualities whatever. The humus necessary for the working of the E.C. has been *increased in quantity* and improved in quality, and if this be used a second time the humification of the excreta will (*cæteris paribus*) be quicker than before. This is a most important matter, but, as we have seen, it is easily explicable now we know that the change is biological and not merely chemical. It is difficult to see that anything except sterilisation could destroy this power of the earth; but it is, of course, conceivable that some undesirable microbe may get a footing, just as happens occasionally with fermentation, and upset or interfere with the normal process.

In alcoholic fermentation the process is accompanied by a very large growth of the ferment, so that the product of yeast from one fermentation is sufficient to induce satisfactory fermentation in (perhaps) 100 times the bulk of the fermentable liquid which yielded it. With ordinary care the brewer not only has no difficulty in perpetuating his fermentations, but has a large surplus of yeast to dispose of. In the same way the process of humification will go on *ad infinitum* if very ordinary care be taken to see that all the conditions are favourable to the process. The power of the earth to humify excreta is not diminished but *is increased by repeated use*, 'as if increase of appetite did grow by what it fed on.' The importance of this fact cannot be overestimated, because with care an E.C. can be satisfactorily managed wherever a few cubic yards of earth and a dry shed to keep it in are obtainable. If the earth which has been used be stored in an open shed, freely exposed to the air and turned over occasionally, it will be ripe again and ready for use in a time varying, in this climate, from three weeks to three months, as the case may be. Mr. F. Bennet, of Marlborough, who is well known as a geo-

logist, has conclusively shown that humification can be perpetuated by the intelligent use of a very few cubic feet of earth. This fact is of the greatest importance as showing the possibilities of the E.C. system in places where earth is not readily obtainable.

If an E.C. is to be entirely satisfactory the following points must be attended to:—

1. It must be well constructed and ventilated, and must be emptied daily.

2. The earth used must be pure garden humus taken from the top layer, and not the under layer, of the soil.

3. The closet-earth must be stored in a dry shed freely exposed to the air and turned over occasionally.

The causes of failure of earth-closets appear to be the following:—

1. The employment of earth or other material which is no longer 'living.' Earth which has been overheated, or taken from a great depth below the surface, has no power of humification, and the same may be said of ashes, which are useful enough to mix with earth in order to increase its absorbent properties, but which are sterile and powerless to effect any change in the organic refuse. Real 'living earth' is unequalled as a deodoriser.

2. The admixture of liquids in too great quantity. The nitrifying and humifying microbes require a certain amount of moisture for their growth, and an average amount of urine mixed with the dejecta is no disadvantage. If, however, the closet be largely used for micturition only (as is very apt to be the case in female communities), the fluid becomes excessive, putrefaction sets in, and the closet becomes offensive. If the closet be emptied every day, as it should be, no serious inconvenience will arise from comparative failure, and if the contents be superficially *buried* every day, as I have

advised, then it matters little how much mismanagement, ignorance, and carelessness is lavished upon this safe and simple contrivance.

In the North of Europe (Denmark, Sweden, and Norway) a closet is in use in which by a very simple contrivance the urine is separated from the solid matter. These closets are or were recently in use even in the city of Copenhagen, and were wonderfully successful.

In female communities it may be advisable to provide a distinct arrangement for micturition only and to allow the urine to run with the house-slops. It need hardly be said that household-slops must on no account be put into the pail of an earth-closet.

In every house there is much organic refuse provided by the kitchen, and in towns where there are no gardens or back-yards this is carried away by the dustmen and hucksters or is burnt upon the kitchen fire.

In a prospectus put forward by the House Refuse Utilisation Society, the following average composition of a ton of London 'house dust' is given:—

	Cwt.	Qr.	Lb.
Crockery	0	0	11¾
Bones	0	0	10½
Iron	0	0	4½
Glass	0	0	10¼
Bottles		No. 5	
Tins	0	0	17
Waste paper	0	3	8
Straw and fibre matter	0	2	13½
Rags	0	0	8½
Vegetable matter	0	3	15
Coal and coke, over 1½-in. pieces	0	0	18
[1] Cinder and ashes (technically known as 'Breeze') sifted through 1½-in. mesh	15	3	24

[1] This material consists of unburnt pieces of coal, cinder, sand, and

This company proposed to sort the material for sale, and to manufacture millboard (from straw and paper) and block fuel from carbonaceous matter, and they calculated a gross return of about 11*s*. per ton.

In country places the putrescible refuse of the kitchen is consigned to the hog-bucket, and that useful animal the pig converts it into pork and manure, or the poultry get the benefit of it, and thus indirectly benefit us. Supposing that neither pigs nor poultry be kept, the safe and economic bestowal of such refuse is perfectly easy. Take a piece of galvanised wire netting three or four feet wide, and with it enclose a circular space about three or four feet in diameter, the netting being fastened and supported by two or three iron or wooden stakes driven into the ground. Into this little wire enclosure throw all refuse from the house and garden which is capable of rotting, the parings and waste of vegetables and other food, the mowings and sweepings of the lawns and paths, weeds, fallen leaves, &c. &c. Such a heap as this, exposed on all sides to the air, is not offensive, and the component parts of it undergo humification. When the wire enclosure will hold no more a little earth must be thrown upon the top, and the heap must be left for several weeks freely exposed to the weather. It will settle down and diminish in bulk, and finally is entirely converted into fine garden mould suitable for potting or

mineral matter which will sift through a mesh of 1½ in., and will be subdivided into the following proportions, viz.:—

Carbon (coal and cinder) . . .	36	per cent.
Sand	41	„
Crockery	10	„
Vegetable matter	3	„
Mud	10	„
	100	„

for enriching the soil. The final act in the management of this refuse-heap is to sift it and consign the residue to the garden bonfire. When one netting enclosure is filled a second must be formed, so that in connexion with a house there must always be two heaps, one forming and the other ripening. Such heaps, if freely exposed on all sides, are not in the smallest degree offensive, and if by any accident they should become so, as by the addition of an excess of cabbage leaves in 'muggy' weather, it is only necessary to put a little earth on the top, when the odour will be at once arrested.

In a kitchen garden the cabbage leaves left upon the ground are apt to be very offensive in the autumn and winter, and the smell from this cause in the market gardens round London is at times sufficient to constitute a veritable nuisance. This nuisance ought not to be suffered, because it can be instantly checked by raking the dead leaves into a heap, and throwing a little earth over them.

All ammoniacal smells should warn the farmer and gardener that he is losing valuable material.

In a house and garden there is a never-ceasing accumulation of refuse and rubbish, and it must be borne in mind that all of it has a definite value. In dealing with such refuse the rule must be, (1) that whatever is capable of rotting must be put in a heap to 'humify;' (2) whatever is not capable of rotting, but is combustible, must be burnt.

In every garden it is necessary to reserve a space all the year through upon which to burn combustible rubbish, and it is needless to say that the resulting ash is of great value as a mineral manure, and contains large quantities of potash and other bases (lime, silica, &c.). When rub-

bish is burnt, the nitrogenous matters (which constitute the staple food of all plants) are lost, but when it is allowed slowly to undergo humification the nitrogen is retained in the form of soluble nitrates and nitrites. It is thus evident that it is wasteful to burn organic matter which is capable of undergoing humification or nitrification. This dogma applies doubly to the cremation of the dead, in which process valuable fuel is used in getting rid of that which easily humifies, but is with difficulty burnt.

Coal-ashes are no less valuable for the soil than wood-ashes, provided, of course, the combustion of the coal has been perfect. The public use the words 'ashes' and 'cinders' as though they meant the same thing, so that it may be well to state that cinders are worse than useless as a manure, and that all ashes added to the ground ought to be either white or red, according to the nature of the coal, and that they ought to be sifted through a fine wire sieve, and whatever is combustible be used for fuel. If the cinders of a house be thoroughly sifted, it will be found that the ash resulting from a ton of coals occupies a very small space, and that the ashes of an average middle-class villa will scarcely fill a couple of bushel-measures in a year.

In every house there is a certain amount of incombustible refuse, in the shape of broken glass, crockery, and the like, and this will be found invaluable whenever good bottom drainage is required, and as a foundation for garden paths.

The secret of good garden paths is to have them well sloped and drained, so that water runs off them readily, and to make them of sterile materials, so that weeds will not readily grow. If beneath the top dressing of gravel a layer of ash (not cinders) be placed, it will be found

that in course of time the path will grow exceedingly hard and firm. Garden paths should be *swept every day*. If leaves are allowed to lie upon paths, and if the earth-worms drag them into the path, the path will soon cease to be sterile and will grow abundant weeds.

There is scarcely any form of domestic refuse which is not serviceable in the garden, and as the occupant of a suburban villa I may state that in the course of fifteen years the 'sanitary' cart belonging to the local Board has never had occasion to call. I feel that it 'robs me of that which not enricheth it, and makes me poor indeed.' I see it at the neighbouring houses taking away a variety of things having a very definite value, and I feel that the times are out of joint when a body of persons co-operate in order to keep a robber with a horse and cart whose duty it is to rob them severally and by turns. I feel it rather a strain upon my conscience to pay rates in support of an institution which is not only useless, but which literally preaches thriftlessness to the unthinking poor.

Amongst the refuse of a house must be reckoned the bones of animals used for food. These are among the things which are believed to be the 'perquisites' of certain persons, and which for one reason or another do not trouble us. Between refuse which is marketable and refuse which is 'taken away' there is a broad distinction, and every one must be left to deal with the former according to his own particular ideas. Bones which have been used for cooking and have had all the gelatin (that 'cultivating medium' for microbes which permeates the uncooked bone) boiled out of them are singularly indestructible, and if buried in the garden remain for years to hinder tillage. They should always be burnt and should be used for manure as 'bone ash,' which is

invaluable. The shells of oysters and other 'shellfish' should also be burnt, as their destruction in the soil is a very slow process.

There is one form of litter or refuse which is largely the result of 'free trade,' and which, perhaps, is more difficult to deal with satisfactorily than any other form of litter, viz. the innumerable tins and canisters in which imported food is brought to our markets. They are incombustible and indestructible, and of very small value as 'scrap' for melting down. It need hardly be said that a very poor or thrifty person will put old tins to a variety of uses. They can be made, for instance, to answer all the purposes of a flower-pot, and I can call to mind a first-rate Swiss hotel where the excellent floral decorations sprang from a basis of concealed meat tins. Finally, the best thing to do with them is to beat them into a manageable bulk with a hammer and bury them at such a depth that they cannot interfere with tillage. They are said to oxidise and disappear very quickly when buried in this way. They form a good foundation for paths and roads when they have been subjected to a thorough pounding with a big hammer.

In concluding the present chapter I am very pleased to be able to quote the opinions of a well-known engineer, the late Mr. Charles Richardson, C.E., of Clifton. No man knew better the aims and objects of engineering and also its limits and the inutility of attempting to disobey the laws of nature. Mr. Richardson's views of the water-closet seem to be identical with my own, and he brings his own experiences by way of illustration. The following quotations are taken from a paper on 'Sewage' read before the Clifton Scientific Club, March 5, 1892:—

'What is the meaning of all our fears for the sanitary

state of our houses, the appointment of sanitary inspectors, the anxiety of householders about the pipes and sewers and the fixing of sewer ventilation-pipes, &c., but a full acknowledgment that there is danger all around us and in every household more or less, since the introduction of the water-closets?

'I may now relate a striking instance of the effect of the introduction of the water-closet system into an old and healthy town.

'I was formerly the owner of an estate which lay about a mile from, but in the same parish as, an old primitive country town of about 2,000 inhabitants. My tenant was the best farmer in the district, and also a churchwarden. The living was a rich one. When the old man died a new vicar came there, who was not satisfied with the old-fashioned vicarage; so, among other improvements, he put into it two water-closets.

'Now up to this time there had been no such thing *in the town*. All the houses had old garden privies, and most of them had a little well of good water. There were no underground drains, but little open ditches carried the rain water into the town ditch, which was also an open ditch at the bottom of a meadow. Now the town had always been very healthy, and fever was almost unknown there. When the vicar had put in his water-closets, two or three of his neighbours followed his example, and they all ran their drains into the town ditch.

'This, of course, changed its contents into *sewage*, which shortly began to give forth its characteristic odour.

'The vicar was the first to notice it, and at the next vestry meeting he told them the ditch must be covered. The smell, of course, kept on growing worse, and the vicar more importunate; but the vestrymen only stared

at him, till at last he told them they *must* do it, or he would write to the Board of Health in London, and have an inspector sent down, who would *order* it to be done: it could be done for 600*l.*, a mason told him. An old farmer then got up and said: "I have known this place, man and boy, for seventy years, and I have never heard a complaint till you came among us. The place is very healthy, and *I* want to know *why* we should *now* be called upon to put our hands into our pockets to such a tune as that."

'The vestrymen would not move; neither did the vicar give in. He wrote to the Board; they sent down an inspector; the ditch was condemned, and ordered to be covered, as the present law directs.

'My tenant then wrote to *me*, telling me of the facts and of the hardship to him of having to pay for this sewer. I immediately wrote to him a reply, which he might show to his vicar. I pointed out forcibly the evils he was bringing upon the town, namely, that he would bring terrible fevers there, till then almost unknown; that he would destroy all the drinking water in the wells; that his sewer would cost at least a thousand pounds, and yet was only the first instalment of a much larger outlay involved in his new system; that, for his own sake, as well as that of his parishioners, I strongly recommended him to take out his water-closets and to go back to the garden privy, but to make it a *dry* privy; that this would cost him very little, and that he would thereby save his poorer neighbours the great cost of the sewer and its further developments, as well as all the other evils I had indicated. My tenant took my letter and laid it before the vicar, who read it through twice, slowly and attentively; and then, pushing it back across the table, said: "Mr. Richardson may know better than

other people; but I prefer to take my own course." My tenant then stood up, picked up the letter, and, bringing his fist down heavily upon the table, said: "I will not act one minute longer as your churchwarden, and I won't give a penny more to your church or schools, or anything you propose; for I feel certain that all those evils mentioned in this letter will surely take place;" and he strode out of the room.

'The culvert was built—it cost 1,200*l.*—and all was quiet for a year or more; and then, in writing to my tenant, I asked him how things were going on. His reply startled me. He said: "The place is full of fever, and it is worse in the vicarage than anywhere else. The parson has already lost *three* of his children, and is himself on his back and hardly expected to get up again."

'The vicar was very bad for a long time, and vowed that if he ever got up again, and placed his foot outside of the parish, he would never place it again within the dreadful place. He did eventually get well, and exchanged livings with another incumbent, accepting one of very little more than half the income.

'The epidemic of typhoid fever in the place was so bad that the London Board again sent down their inspector to report upon it. His report was that all the wells were contaminated, that more sewers must be built, and that *waterworks* must be constructed to convey *good* water to the town from the hills six miles away.

'I sold my estate shortly after this, and do not know what has been done there since 1878. But does it not appear strange that the *Law* should give its support to the mere whim of an individual, and thus enable him to bring such trouble, loss, and death into a place hitherto healthy?

'The *effect* of the introduction of the water-closet into a new locality is very striking in this instance. Here we have an old market town, of over 2,000 inhabitants at the beginning of this century; a place of little change, with its weekly markets and its quarterly fairs, with its old-fashioned cottages, each with its bit of garden, and most of them with little wells of *good* water, notwithstanding the old-fashioned cesspit privy in the garden. This had gone on for years upon years, through many generations, and yet fever was quite a rare thing in the town under these old conditions. Suddenly, the water-closet was introduced, and three years later an epidemic of typhoid fever swept the place, which was so bad and fatal (particularly in those houses which had connexions with the new drains) that the central Board in London sent down a special officer to report upon it!

'I have been personally connected with other cases, all of which indicate the same result, though not perhaps in so striking a manner; and I am fully convinced that the water-closet system must be abolished before long or we shall have no wholesome water left in the moderately populous parts of England. If this is so, the sooner we set about the reform the better it will be for every one, and the sooner we shall have our beautiful water-springs and pure rivulets restored to us.'

The correct principle of dealing with excrement is that laid down by Mr. Richardson. The principle is dryness and thorough exposure to the air; and if the sunlight have access also so much the better. I have lately remodelled an old privy on the plan advocated by Mr. Richardson, and have been astonished at the result. This old pit privy was emptied in June 1898. When it had been previously emptied I do not know. The con-

tents were offensive, and were mixed with a hundred and one things—wire netting, brickbats, canisters, broken crockery, &c.—which had been thrown down it 'out of sight,' and which, as they interfered with tillage, very greatly lessened the practical manurial value of the excrement. The contents were superficially buried, and in a very short time they were sufficiently sweet to allow of the undesirable ingredients being got out with a fork, and the ground being properly dug, tilled, and planted.

The pit was filled up level with the ground, and the privy seat was raised 18 in., and an approach to it made with three concrete steps. The catch below the seat was concreted and cemented, and the floor of it was made to slope towards an outlet 15 in. wide and 12 in. high on the ground level. This outlet was closed by a piece of wire netting stretched on a frame which could be hung over the opening. The object of this was to prevent the access of animals which feed on garbage, without preventing the access of air. Before the privy was used a little straw was placed on the bottom of the catch and barrow-load of dry earth was tipped opposite the outlet to absorb the urine, which would flow away down the sloping floor of the concreted catch. In the privy was placed a box of earth and a trowel, so that after the privy had been used a little earth might be thrown through the seat. The earth under such circumstances is really not necessary, and is added more for æsthetic reasons than from any sanitary necessity. This privy, which has been in constant use, is always as sweet as possible. It can be emptied in two minutes with a garden hoe and shovel, and has, in fact, been emptied several times, for whenever the gardener wants a little manure for horticultural purposes he knows where to go for that which

is unsurpassed and which he can obtain and utilise without any offence whatever. The success of this privy has convinced me that the principle upon which it is constructed is sound, and in it, I believe, we have for cottages and small houses the solution of the sewage difficulty. It is a great gain that into such a privy rubbish which hinders tillage is not likely to be thrown, and certainly never should be thrown.

Now such a privy might very well be attached to a house by means of a lobby having cross ventilation, and seeing that a fall is necessary for such a privy, and that it is necessary to raise the seat, it is obvious that there are advantages in approaching such a privy from the first or bedroom floor of a house.

I need not remind the reader that the angle turret which is so common in Scotch baronial castles is said to have been used for sanitary purposes, the excrement having been allowed to drop on to the ground beneath.

A house which I own at Andover became vacant in 1893, and I have been trying the experiment of giving it a dry privy, which should be of such a kind that no lady would object to use it.

Now I hold that every closet, whether a dry closet or a water closet, should be sequestered from the main structure of the house, and should be approached by a lobby having cross ventilation. Those who in the present day put closets and waste-pipes within the four walls which enclose the living-rooms are not abreast of modern civilisation. The simplest plan for effecting my object in the present case seemed to be to throw an arch across the entrance to the stable yard, to place the ventilated passage on the top of the arch, and the closet on the far side of it on a level with the first floor, and with a capacious vault or 'catch' beneath it. The catch,

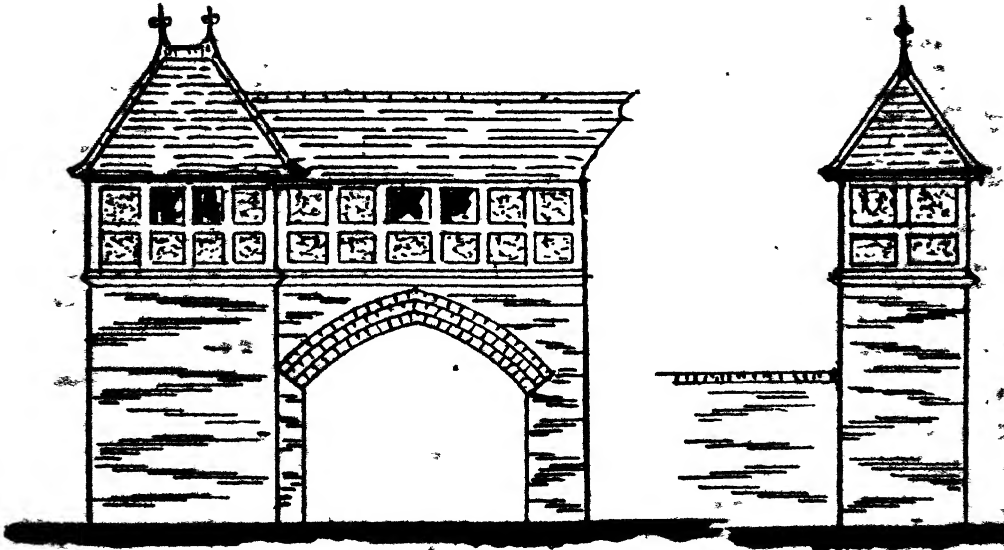


FIG. 11. DRY CLOSET APPROACHED BY LOBBY HAVING CROSS VENTILATION

though larger, is exactly on the same principle as that which has been described, and it has been provided with eight large air bricks, three of which are just below the level of the closet seat, three near the ground level, and two intermediate in position. The bottom of the door is some 18 in. above the ground level, and in addition there is an opening for a dust-shoot, protected by a fine grating so as to ensure that only dust and ashes and not cinders or clinkers are thrown into it. There can be no doubt that plenty of fresh air will get access to this receptacle. The arch is useful in another way, because the pipe which carries the bedroom slops is on a level with the top of it, and then dips down to deliver the slops in a gutter on the surface of the ground. Thus underground pipes and syphon-bends are rendered unnecessary, and, the fall being very great, no freezing can take place in the pipe.

1. The seat and accessories are made of the best polished mahogany, because I am very strongly of opinion that smartness leads to cleanliness.

2. The seat is only 14 in. above the ground, which is some 4 in. less than is customary. Closet seats are, as a rule, too high, and the low seat, with the position it necessitates, has certain physiological advantages, among which may be mentioned the fact that the dejecta fall vertically downwards. It has one disadvantage, viz. that elderly people find a difficulty in rising, but this objection is easily overcome by fixing a handle in the wall, so that the arms may assist the feeble legs in the act of resuming the erect position.

The supply of earth for this closet is kept in a box alongside the seat, and this box is filled from the outside by means of a hopper so arranged that the man who brings a fresh supply of earth cannot see or be seen

by any chance occupant of the closet. *This, again, is* an important trifle. The earth bin is big enough to hold several bushels of earth.

To return from the detail of the pan and seat to the principle involved in this method of treating excremental matters. The dry catch as depicted has great advantages over any pail system, because with it one is less absolutely dependent on the scavenger. With the pail system, if the scavenger is unable from any cause, such as illness, to perform his daily duty, trouble begins to arise instantly; but with the far greater capacity of the dry catch, the accidental absence of the scavenger for a few days, or even a few weeks, is of very little practical importance, because the absence of urine prevents putrefaction and offence. My cottages, as will be described, are provided with pails, which are emptied every day. This has answered well, because the garden where the excrement is buried is only a few yards from the cottages; but were I to begin *de novo*, I should adopt the dry catch as the method which not only allows greater freedom to the owner, but the one which is probably the most economical. The pail does not allow of that perfect aeration which is possible in the dry catch, and, as it retains all the urine, it is very liable to become offensive if there be any delay in removing its contents, and removal is difficult because of the sloppiness of the contents. I believe that the dry catch, properly constructed, is admirably adapted for use in towns where dry methods of excrement disposal are in vogue. Where dry methods are in vogue it is essential that the excremental matters should be removed *every day*, and any sanitary authority which intends to adopt such methods must face this fact, and will certainly find that by doing so economy and efficiency are both enhanced.

If the catch be made of a proper curve and slope, and if the scavengers' shovels have a curve to correspond, it is certain that the daily removal of the three pounds' weight of excrement, which is certainly the maximum amount of a household of five persons, and its transference to a suitable collecting cart, could be effected in a fractional part of a minute. If, *with daily removal* in view, the privies of city cottages were suitably planned, it is tolerably certain that a scavenger would clear sixty privies in an hour. It has always appeared to me that the pails which are used in big towns are the clumsiest and most unsatisfactory apparatus ever devised for excrement disposal, and that to allow such pails to collect fæces and urine for a whole week, until the contents are in a state of putrefaction calculated to poison the *two* unhappy men who are required to manipulate them, is wholly indefensible.

In towns the use of dry earth for absorbing the effluent urine, or for adding to the closets, is, or will be said to be, impracticable. In any case it is easier to move the excreta without admixture.

It goes without saying that the 'catch' might be made to receive the dust and ashes of the house, but in such case a grating must be provided to the dust-shoot, so as to ensure that cinders and other coarse materials do not get mixed with the excremental matters and diminish their practical manurial value. To do this is to increase the difficulty of ultimate disposal. I think the difficulties of removing excremental matters from cities have been exaggerated, and it is certain that they have been intensified by faulty methods. If everything were done, as I have suggested, to facilitate daily removal, I think that one scavenger, with a donkey and small tank upon wheels, might collect from at least 300

cottages per diem, the excrement of 1,500 people weighing about 8 cwt. On this calculation, the daily excrement of 30,000 people would about fill an ordinary 10-ton railway truck, and if a serious effort were made to despatch this material direct to the land it would merely mean that fewer railway trucks would be 'returned empty' than at present is the case. To believe that there would be any difficulty in transporting this stuff for any distance and without offence is to hold a very poor opinion of human ingenuity. To this end it must be fairly dry. The success attained at Manchester in the reclamation of Carrington Moss and Chat Moss by the application of dry sewage refuse will be found fully described in my Milroy Lectures.

It has been said that classification is the basis of all science, and it most certainly is the basis of the scientific disposal of refuse. Refuse matter is most varied in its nature, and the items of which it is composed—excrement, rags, bones, paper, straw, sawdust, and other packing materials, cinders and ashes, old crockery, broken glass, old metal, &c.—all demand a different method of treatment.

When I see the grimy gentlemen in fantailed hats engaged in the marvellous operation of climbing over spiked railings with the object of filling a huge lumbering cart with a *mixture* of some or all of the things mentioned above, I feel that they are engaged in a bit of wilful mischief, and are merely increasing the dangers and difficulties of that sorting which is inevitable. In cities house-refuse should be collected every day, and the sorting should be done at once by the collector, with the intelligent co-operation of the householder. Things dissimilar in nature should never be mixed. The first division is into putrescible and non-putrescible, and the

former should be sent forthwith to the farmer to be dug into the ground. The non-putrescible refuse—glass, crockery, cinder, ash, metal—if sorted and temporarily stored in bins would probably pay the cost of its collection and removal, and might perhaps yield a slight return. A great deal of the non-putrescible refuse might be of use to the sanitary authority on the spot for making foundations for paths and roads, or for scattering on the streets in slippery or frosty weather. Ash (not cinder) beneath the gravel on a garden path gives in time a firmness and stability which is remarkable. Whether it would work in with the macadam in road-making and cause a similar improvement in the road I do not know. It is difficult to understand why it should not do so. Non-putrescible refuse is not a danger to health, and it is certain that a great deal of it might be used for various purposes by the sanitary authority.

This immediate sorting is only possible when such materials are collected every day and the bulk is small.

It seems to me that much of our municipal scavenging is too magnificent, and that it is often inefficient in proportion to its magnificence. The nimble boys who collect the street droppings and store them in bins which contain nothing but the valuable and marketable manure are the type of what is good. The showy Clydesdale slowly dragging the most lumbering cart conceivable filled with an unmarketable mixture is the type of what is bad.

Farmers are shy of taking London sweepings because, as one told me, 'they send such stuff.' All organic refuse is good for the land, but the farmer wants it in a form which does not hinder tillage. Pieces of oil-cloth, hamper lids, dead dogs and cats, and old tin canisters are a nuisance to the farmer, and a very slight ad-

mixture of such things spoils the practical value (a different thing to theoretical value) of the manure which is mixed with them.

What is true of dry or semi-dry refuse is also true of liquid refuse. It is the admixture of totally dissimilar things which is, I believe, the main cause of our absolute failure to satisfactorily deal with sewage. In country places where excrement is collected dry it is a very simple matter to filter the house-slops and purify them sufficiently to be returned to a stream. The difficulty and danger are enormously increased if the excrement be mixed with the slops. The cry at present is, 'Tout à l'égout,' a cry which is bred of ignorance, moral cowardice, and despair.

In cities where dye-works, tanneries, slaughter-houses, chemical works, and factories of all kinds are allowed to send their refuse into the rivers, it makes little difference whether the excrement of the inhabitants be added or not, and there are not wanting engineers who urge that in dealing with purely domestic sewage it makes little difference whether or not the excrement is mixed with the slops. Engineers who urge this cannot have studied the question in its purely domestic aspects. From practical study of the question I am sure that it makes *all* the difference. If household-slops be unmixed with excrement, then filtration can be commenced immediately they escape from the house, which is impossible if excrement be mixed with them. This is so easily effected that the householder in suburban country places ought to be compelled to return a clear effluent to the gutters. If manufacturing refuse (strong acids, strong alkalies, chemicals, antiseptics, &c.) be mixed with sewage, it is clear that, as a manure, it becomes worse than valueless, and it is also clear that no one method

of treatment can possibly purify a mixture which is not the same from day to day or from hour to hour, and the composition of which is scarcely to be guessed at.

The sanitarian who loses sight of classification, and who, in his eagerness for a big scheme, is neglectful of details, has not mastered the elements of his trade.

The only rational treatment for excremental matters is, as has been said, immediate superficial burial, with a view to the production of crops. It is to be hoped that, with this object in view, some municipality will purchase a tract of land and endeavour to give the poor an object-lesson on the right use of refuse. If convenient access to such a farm by means of canal, river, or railway siding could be obtained, it would make little difference whether it was two or twenty miles from the town, but the nearer the land is to the houses the better. Such a farm must be hand-tilled, and, if skilfully hand-tilled, would certainly produce as much food as a market garden. It would employ an enormous amount of labour, and would at least pay its labour bill. I am not advocating that such a farm should be used as a playground for the semi-criminal, semi-imbecile, and generally incompetent class who go to form the 'unemployed;' for the trade of agriculture, to be successful, demands both skill and energy. The 'unemployed' should be set to stone-breaking, street-sweeping, dung-collecting, road picking and ramming, and scavenging generally, under the eye of foremen in town, and then, if found worthy, they might be exported to the farm.

The construction of 'dry' urinals, in which the urine is taken up by absorbent material, would, there can be no doubt, prove under many conditions to be both

economical and wholesome. The absorbent material used must differ according to circumstances. Dry litter of any kind would probably be found to answer the purpose. In constructing such a urinal care should be taken (1) to provide as large an evaporating surface as possible; (2) to give drainage; (3) to have the urinal of such a shape as to allow the thorough stirring of the absorbent material; (4) to protect the surface by a grating or wire netting, so that there can be no mischievous meddling with the absorbent material; (5) to protect from rain.

The only material of which the author has had any practical experience is sawdust. Mr. Jacomb Hood, one of the engineers of the London and South-Western Railway, acting on the author's advice, erected in some carpentering works at Twickenham a series of closets provided with the dry catch. For the disposal of the urine the author recommended a trough filled with absorbent material and provided with drainage. The absorbent material, which was readily available, was sawdust, and this it was which led to the experiments with sawdust detailed in an earlier chapter. (See p. 171 *et seq.*)

The yard at Twickenham is used by some 160 workmen, so that the dry closet and 'dry' urinal were here subjected to a good practical trial.

On July 4, 1894, Mr. Jacomb Hood wrote spontaneously as follows:—'Our sanitary arrangements at Twickenham have now been in regular working for more than three months with, to my mind, unqualified success. I inspected the privies yesterday on a surprise visit, and with the thermometer at about 80° in the shade, and found the place everything that could be desired.' A fortnight later the author visited this yard,

and found everything in excellent order, and all perfectly sweet and wholesome.

The trough of sawdust used as a urinal had been changed once only since its erection, about four months previously, and it was perfectly sweet and had no odour of urine or putrefaction. Once in twenty-four hours it was stirred and turned over by the man in charge, and certainly as regards odour it offered the most striking contrast to any water-urinal which the author has ever seen. The amount of drainage from it had been insignificant and inoffensive.

For villages, roadside public-houses, cricket grounds, Thames houseboats, &c., there can be no doubt that a dry urinal would prove effective and cheap.

One must always, in making such recommendations, have an eye to the ultimate disposal of the material saturated with urine, by application to the soil.

Now, it should be known that sawdust, notwithstanding that it is a pure vegetable product, has an evil reputation as a manure.

In Loudon's 'Encyclopædia of Gardening' (Longmans, 1878) I find (p. 416) :—

'Inert peaty matter, tanners' spent bark, shavings of wood, and sawdust, though they consist almost entirely of woody fibre, are of very little use as manures, unless they be mixed with lime or some other alkali which will render the humus which they form soluble in water. Tanners' bark decaying slowly, and evolving considerable heat during the process, is useful as a hot-bed.'

The general opinion among agriculturists seems to be that sawdust is apt to decrease the fertility of the soil when first applied, but that ultimately it does good.

The probable explanation of this is to be found in

the antiseptic bodies—such as resin and turpentine—which sawdust contains, and which prevent the growth of those organisms which are essential for humification.

It is to be noted that Loudon recommends that these bodies be mixed with 'lime or some other alkali,' and it is probable that the ammonia derived from the urine would answer the same purpose.

Now, it is tolerably plain that so long as antiseptics remain in sawdust in sufficient quantity to prevent the putrefaction of urine mixed with it, it is not fitted for agricultural purposes; but that so soon as the mixture of sawdust and urine becomes offensive, it is fit to be used as dung, and the sooner it is so used the better.

If sawdust be scarce, there is no reason why it should not be used a second time after drying in a shed. The great antiseptic power of sawdust is testified to by its universal employment in butchers' shops.

The remarks which we have made with regard to sawdust are probably applicable to peat and peat-dust. By some the use of peat-dust as an absorbent and deodoriser of fæcal matters is strongly advocated. In many towns of Holland, North Germany, and Scandinavia it is used for this purpose by the sanitary authorities. When properly dried (which is not always the case) it is said to be capable of absorbing eight times its weight in urine. Its deodorising power is very great. Those who are interested in the sale of this article state that it is superior to dry earth for use in closets. There can be no doubt as to its great utility and efficacy as an absorbent and deodoriser, and in districts where peat is found its use for sanitary purposes should be encouraged.

That it is superior to 'dry earth' it is difficult to believe; and if the material is to be used for agricultural

purposes one must not forget that the peat is, to begin with, both sterile and antiseptic, and it is doubtful whether the process of 'humification' would be so rapid with peat as with earth.

Dung made with peat-litter is, owing to its high absorbent power, very rich in nitrogen, but it is dangerous to judge of a manure by its analysis alone; and I find in the 'Journal of the Royal Agricultural Society' (Vol. 4, part iv. p. 775) a statement that 'the Bordeaux Tramway Company, which tried the experiment of peat-moss for litter, has now abandoned the use of it, partly because of the difficulty of disposing of the manure, and partly because the litter, which was sold to them by weight, was frequently supplied in a damp condition, which considerably reduced its utility.' A large market gardener writing to the author says: 'The peat or moss manure I consider of very little value for our crops. I will not have it for fetching. It might do for corn crops, but then straw manure is of far more value.'

In the 'Lancet' for July 21, 1894, is an interesting account of the city of Stockholm, which had a population in 1893 of over 249,000, a figure which closely approximates to that of the 'central' districts of London. The death-rate of Stockholm has gradually decreased in the last thirty years from 35·3 to 20·3. There are no water-closets in the city, the fæcal matter being removed in a solid state by the municipality. As a consequence of the absence of water-closets the consumption of water averages only 18·4 gallons per head. The death-rate per 1,000 from typhoid fever is only 0·18.

'Stockholm is a good example,' says the writer of the article, 'of a city whose death-rate has steadily diminished with the introduction of a wisely directed sanitary administration, and illustrates also the fact

that this end can be attained without the introduction of the "tout à l'égout" system.' The winter climate of Stockholm is very severe, and this makes the reduction of the death-rate very remarkable.

Christiania, with a population of 161,157 in 1893, enjoys climatic conditions similar to those of Stockholm, and, as in Stockholm, there are no water-closets, the excreta being treated by various dry methods. The average consumption of water is twenty-five gallons per head of population. In 1892 the birth-rate was 33·5, and the death-rate 19·3. 'It is worthy of note,' says the writer in the 'Lancet,' 'that typhoid fever caused only six deaths.'

In Berlin, where the excreta are now all water-carried, there has been a reduction of death-rate nearly as great as in Stockholm. Berlin has about trebled its population in the last thirty years, just as Christiania and Stockholm have done; and it must be assumed that the lessened mortality of these cities, equally with that of London, is due as much to dilution by new and wealthy suburbs as to actual improvement of the old insanitary nuclei.

The question of slop-water in villages is a burning one. The following extract from a report made by the author to the authorities of a small rural town which disposes of excremental material by dry methods will therefore not be out of place:—

'It would probably be advisable to deal with the *domestic slop-water* on a comprehensive plan.

'When water is "laid on," inordinate quantities are often used. Fixed baths, which are pure luxuries, mean that individuals wash in thirty gallons of water instead of three, and that some twenty-seven gallons of extra

slop-water, for each individual using the bath, has to be disposed of. Houses with water laid on seldom have wells and pumps of their own; the soil is not dried by pumping, while it is constantly being soaked with water, of which a continuous stream can be obtained by turning a tap. Thus, the luxuries of the few tend to entail considerable expense upon the mass of the ratepayers.

'The supply of water by meter would do much to check extravagance in the use of water.

'The foulness of domestic slop-water, however, bears an inverse ratio to its quantity, and much of the waste water flowing from the modern house is almost clean, and, *provided it is not mixed with excremental matters*, is innocuous and inoffensive.

'To deal effectually with domestic slop-water, the following conditions are essential:—

'1. Excrement must be excluded.

'2. Manufacturing waste of all kinds (which not infrequently contains chemicals and corrosives) must also be rigorously excluded, unless it has been previously subjected to such treatment as would render it fit (legally) to be discharged into a river.

'3. The slop-water must never be discharged from the house below the level of the ground, and the coarser impurities should be strained out, before being received by the authority, by passing it through a filter, provided by the householder, and made of gravel and cinders, contained in a cistern. This would prove to be a very simple matter.

'4. In its transit to the river or filter bed, slop-water should be kept as near the surface of the ground as possible, and should be freely exposed to the air in its entire course. Slop-water allowed to stagnate in "traps" or underground cesspools or sewers, away from the air and

sunlight, soon becomes foul, but if kept on the surface it is never offensive.

'To carry out these principles it will be necessary to discourage the building of underground kitchens and sculleries, not only because they are in themselves unwholesome, but because they lead to the discharge of foul water far below the level of the ground, which enormously increases the difficulty of any sanitary authority which may be called upon to deal with it.

'The purification of the slop-water should be commenced at the point of discharge, and, but for its unsightliness, there is no reason why it should not run, after coarse filtration, in open channels by the roadside, and soak away in part as it runs. It would probably be advisable to construct a channel, running at the edge of the pavement or side-walk, and protected by a grating. This channel should be inside the kerb, in order to protect it from damage by heavy vehicles, should be floored with perforated tiles, and should have good bottom drainage. The sanitary authority has at hand a large amount of material in the shape of old metal (which should be previously hammered into a small compass), broken crockery, builders' rubbish, &c., which should be utilised for giving bottom drainage to the channels. If this were done a great part of the water would soak into the ground before it reached the outflow, and that which did reach the outflow would require very little (if any) treatment before being discharged. The sides of the roads in proximity to the slop-channels should be planted with trees, which would absorb the moisture from the channels and freshen the air.

'It might be necessary to discharge the slop-water on to a filter bed, in order that it may be still further purified before reaching the river, but as at present the

fouling of the streams by slop-water is in your town scarcely noticeable, the necessity for this is doubtful. I shall return to this point again.

'I have thus recommended that the slop-water shall run and soak away in open channels, protected by gratings if necessary, and my experience leads me to say that it will continue to soak away, even in the severest frosts. This method has the following advantages:—

'1. Exposure to air, sun, heat, cold and drying winds, whereby putrefaction is held in check and the escape of foul gases into houses rendered impossible.

'2. The open channel is, as compared with a deep-lying sewer, inexpensive, and any derangement thereof becomes instantly manifest and is easily corrected.

'3. The surface channel allows the slop-water to flow on to a filter bed (should such be necessary) without the great expense of pumping machinery.

'It is commonly asserted that, as it is necessary to arrange for the disposal of slop-water, it is bad economy not to include the excremental matters also, and carry everything underground in a system of sewers. I believe that this doctrine is erroneous and is largely answerable for the insuperable difficulties which have arisen in every place without exception where it has been tried.

'In your town, where four-fifths of the houses are without water-closets, a slop-water scheme will complete the sanitation in over 80 per cent. of the houses, and will relieve the remaining 20 per cent. of all except the water-closet waste, which constitutes about one-tenth of the domestic sewage of these houses. Thus, of the entire liquid sewage, 98 per cent. will be disposed of by a slop-water system and only 2 per cent.

will find its way into the cemented cesspools, which, as they will receive only one-tenth of the amount formerly allowed to run into them, will need emptying once in place of ten times.

'Cesspools are hygienically quite indefensible, but if the householder be unwilling to use a "dry closet" he must run his risk. I believe, however, that dry closets can be constructed so as to be fully equal to water-closets in the matter of convenience and decency, and they are always far safer hygienically than are water-closets. Water-closet waste consists of an average of three or four ounces (say four) of fæces, half a pint of urine, a square foot of paper, and three gallons (480 fluid ounces, or 30 lb. weight) of water. The addition of water increases the weight of matter to be dealt with 120 times, and increases the difficulty of dealing with it to an incalculable extent. When the four ounces of excrement are mixed with the whole of the slop-water (say 30 gallons) then the difficulties are ten times greater. If at any future time water-closets should become general, I should strongly advise that their contents be dealt with on a separate system, unmixed with slop-water or town refuse. If this were done, it might be paid for by a tax on the water-closets, and there would be some chance of treating the waste successfully, which, as yet, has been done nowhere. If the slop-water be dealt with by the "authority," it will be no great hardship for the landowner who wishes to develop his land into a building estate to set apart a portion of his land for the reception and treatment of the water-closet waste of the houses erected on his land.

'It may be necessary to state that I do not advocate the bringing of the slop-water of the district to *one point.* This would be a great mistake. Provided there are no

pumping, it matters little how many filter beds you have or how wide apart they are. The number and situation will be determined by the local circumstances.

'I think that if the sanitary authority deal with the slop-water of new houses that will be doing all that can reasonably be asked of them, and they will not jeopardise the prosperity of their district by any undue increase of rates.

'I would remind your committee that in the south of London the development of some districts is supposed to have been seriously checked by the burden of sanitary rates, which has become heavier than the average householder can bear.

'As to slop-filters (should they be necessary), I think it will be quite possible to combine the two operations of slop-filtering and gardening on one piece of land, provided the land chosen is in such a situation as to allow of the slop-water being conveyed to it by gravitation only. Let me imagine a piece of ground measuring 170 yards from east to west and 120 yards from north to south. This would contain 4 acres and 1,040 square yards. If this were surrounded by a ditch 2 feet wide, and if the plot were divided into four strips of an acre each by three similar ditches running from north to south, then we should have rather more than 4 acres of land surrounded and intersected by 940 yards of ditch 2 feet in width. The earth removed from the ditch would be used to raise and strengthen the banks, and if we may take the available depth of the ditch at 18 inches, then the holding capacity of the entire ditch would amount to 8,460 cubic feet, or over 50,000 gallons, the amount of slop-water provided by some 2,000 persons.

'Wherever slop-water flows, planting should be carried out methodically. The ditches in the garden

plots should be stuck on both sides with shoots of the willow or privet, or such tree or shrub as may be suitable to the soil and situation. These would serve to protect and consolidate the banks, to absorb the moisture from the soil, to hide the ditch, to purify the air above it, to protect the garden ground from wind, and to provide dead leaves (and ash from the clippings) which would help to improve the fertility of the soil.

'The recommendations I have made will involve no great outlay of capital, and, unless an opportunity occur of purchasing land on favourable terms, I advise that the work be carried out if possible without raising a loan.'

CHAPTER IX

PERSONAL EXPERIENCES IN A COUNTRY TOWN

In the winter of 1881–2 the writer purchased a house and about two acres of garden in the town of Andover. The house had been for some time untenanted, and the garden was so overgrown with weeds that the paths were scarcely recognisable. The house is situated in one of the most low-lying parts of the town, and is one of a type very common in country towns, being entered directly from the street, while behind it is a garden as umbrageous and secluded as can be desired, running down to the banks of a trout stream (the Anton).

Our forefathers generally chose the valley rather than the hillside as a spot for building. Valleys are fertile and sheltered, and present no difficulties in the matter of water-supply, a most important point when every gallon of water had to be raised by hand. A situation on the banks of a stream, by pure rushing water, was one to be coveted. The river was a source of power, and was always used to drive a mill; it was a source of food, for it was kept well stocked with fish; and it was a source of water which might safely be used for drinking or other purposes, and which brought fertility to the soil. In the valley life can be sustained at a lower cost than on the hill, and hence its popularity.

The nineteenth century in Great Britain has been

an era of money-getting; the population has increased threefold, and a very large proportion have a great deal more wealth than is sufficient to purchase the necessaries of life. We have, among other luxuries of the age, the great boon of water under pressure, which enables persons to build houses in elevated positions, and which, rightly used, should in time make the hill-top blossom as luxuriantly as the valley. The right use of this water under pressure should be its application to the land round the house as it runs to waste after having served for household purposes. It would then percolate into the soil, conferring greatly increased fertility, and find its way to the valley again by natural channels, and in doing so would be a source of danger to no one. Unfortunately the water-pipe as it climbs the hill is always accompanied by its filthy companion, the sewer-pipe—that sanitary Satan which has brought 'death into the world and all our woe.' Through this pipe the waste waters return to the valley, charged with every foul abomination. This waste water or sewage periodically floods the low-lying situations, is a source of perennial offence and expense, and finally so fouls the valley-stream that none dare drink of it. Thus, under existing circumstances, those who live on high ground get a minimum amount of good from the water which is pumped up to them, while those who remain in the valley get a maximum amount of harm, and suffer financially from the depreciation of their property. This state of things must go on until it is made compulsory upon each individual householder or landowner to apply the waste waters to the land and return a clear and clean effluent to the public streams. The writer's Utopia is a place where there are water-pipes and no sewer-pipes, where every cottage on a hillside has around it an allotment sufficient to be fertilised by and to purify

the waste waters, which should run clear as crystal in open channels, without needing so-called ventilation.

In country places water under pressure was a rare luxury at the beginning of the present century. Water was pumped from a well on the premises, house-slops flowed in open channels to the nearest stream, and excremental matters were deposited in a *dry* pit. The town of Andover at this time had open gutters running down either side of the street, crossed by little bridges opposite the doors. With such an arrangement pollution of wells was not likely to occur, there is no record of any epidemic disease, and the river was full of fish. Every house had ample curtilage, and most of the houses good gardens, for the town never having been a walled fortress, there had never been any necessity for overcrowding. With the introduction of the water-closet it is probable that the open gutters became unbearable, and it is certain that the old *dry* pits became converted into cesspools which endangered the purity of the wells. Between 1850 and 1860 the open gutters were replaced by underground drains. These underground sewer-drains, unlike the open gutters, have to carry semi-solids as well as liquids. Blockages are necessarily frequent in low-lying places where the drains are of small calibre and the fall insufficient. This was (and is) particularly frequent in the street where the writer's house is situated, and during heavy storms the sewage matter flowing from higher levels has occasionally been forced out of the drains and has been deposited in the street. This state of things necessarily depreciated the value of property in the street, and as it was whispered that the kitchen of the house which the writer purchased was occasionally flooded, it was not surprising that the sum ultimately accepted for the property was more than forty

per cent. below the price originally named as a reserve by the vendor when it was put up to auction. Before purchasing, the writer satisfied himself by a careful examination of the floors that the house was not damp, and soon after purchasing he found by ocular demonstration during a storm that the flooding of the kitchens was caused by sewer-water rushing in through *an untrapped drain.* No better example could be found of the depreciation of property in the valley by the filth flowing from higher situations. To move the kitchen sink and cut it off entirely from direct communication with the sewer was an easy matter. The house was soon let, and the writer retained about two-thirds of the garden in his own hands. This garden is situated by the River Anton, 189 ft. above Ordnance datum. To the north and east the ground rises gradually until at the distance of a mile or so an elevation of 280 ft. is reached. It is bounded on the west by the River Anton, on the north and east by a wall, and on the south by a double row of cottages called 'Portland Place.'

These cottages collectively form a little street leading to a private bridge over the Anton. They were owned by four or five different persons and had been built at various times, the name of 'Portland' possibly indicating that the Premiership of the Duke of Portland in 1807 was the date of the chief part of them. Many of these cottages ought never to have been built, and collectively they had two radical faults: (1) insufficient curtilage, and (2) no entrance to the back premises except through the street door. In these days one hopes that no sanitary authority would allow such cottages to be built. If there be no way of removing filth except through the parlour and front door, it is certain that the evil day will be put off and that the filth will be allowed to accumulate. The

collection of dirt and rubbish and the overloaded condition of some of the old privies in the back-yards of these cottages are better imagined than described. These privies had been dug years previously, and the majority of them were waterlogged, because in this particular position one cannot dig a hole three feet deep without coming to water. It is essential that a privy pit should be dry. Waterlogged privies, such as these were, assert themselves in a most unpleasant manner and make a large area round them the reverse of pleasant. In some of these privies the enterprising owner had fixed water-closets, but as there was scarcely any fall to the sewer in the street, and as old boots and bits of wood and oyster-shells mysteriously found their way into the pipes, the cottages with w.c.s were perhaps worse off than those with the more primitive arrangement. The back doors of these cottages were at various levels, and the cottages were divided into groups of three or four by walls. The slop-water was taken by two underground drains, one running eastward to the sewer in the street and the other running westward to a little stream the course of which is parallel to the Anton and a few yards from its left bank. The natural slope of the surface in this situation is from the street to the stream, the latter being nearly two feet lower than the former. This underground drain was provided with the usual gratings, which were a frequent cause of petty disputes, and the drain itself was generally blocked at some point, and was a perennial source of income to the neighbouring builder. Portland Place consists of twenty-seven cottages and three other tenements at its western end, which, having more curtilage, might be spoken of as villas. These need to be mentioned, because two of them at least were

provided with w.c.s which drained direct into the 'little stream' of which mention has been made.

This 'Portland Place' is close to the house which the writer purchased, and helped, it need not be said, to materially depress its value. The original object of this purchase was the garden, for amusement and the production of fruit and vegetables, and doubtless the purchaser was influenced also by a sort of sentimental regard for a spot which he had known all his life. Had this not been the case he would probably have hesitated longer before buying a property which had so many sanitary drawbacks in its surroundings.

Mention has been made of the River Anton and the 'little stream' which runs parallel to it. This latter stream rises as a spring beneath a summer-house near the centre of the writer's garden and joins the main stream of the Anton just below the first mill a few hundred yards lower down. This stream, which is only a foot or two in width, used to be a pretty little babbling brook. It received a quota of slop-water from Portland Place, but this was no annoyance whatever, as it caused only a passing turbidity. When, however, with what is called the 'advance of civilisation' two or three of the 'villas' at the west end of Portland Place adopted w.c.s, it will readily be conceived that the beauty of this little stream vanished. It became filthy and malodorous. Then commenced the covering in of the stream, in the belief, which is so prevalent in the present day, that evils which are hidden are thereby remedied.

When streams of this kind are covered in it is certain that in course of time blockages will occur, and our little stream was no exception. It was covered in, in fact, and for the reasons given; it got blocked, and with the

result that the garden I had purchased was improperly drained and the land more or less sour.

It was evident that the only chance of making this garden at once pleasant and productive was to get possession of the neighbouring cottages, and so to obtain complete command of the 'little stream.' Circumstances proved favourable. The property came into the market, and the writer soon became the owner of all the cottages and villas which were essential (twenty-three in all).

The various steps in the improvement of this property have been as follows:—

1. The demolition of the partition-walls between the back-yards of the cottages, and the provision of means of access and egress to these back premises for the purpose of scavenging.

2. The removal of nine w.c.s and the filling up of all the old privy pits, and the substitution for these of an arrangement of pails which might be used on the earth system.

3. The removal of the underground slop-drain and its replacement by an *open* gutter made of Staffordshire brick running from east to west—*i.e.* taking the course of the natural slope of the ground.

4. The opening up of the 'little stream' in every part of its course, and the removal of the blockages which had occurred in two or three places.

This was followed by a permanent fall of the level of the stream in the writer's garden amounting to nine inches!

5. The providing for the daily scavenging of the cottages.

The last measure has been the most important of all. A man was engaged to act as scavenger and under-

gardener, whose duty it has been to remove the closet pails *every morning* and bury their contents superficially in the garden. For such a plan to succeed it is essential that the removals should be daily, and the writer has elsewhere entered fully into the economic aspects of *daily* versus *weekly* removals.

The success of this plan has been complete.

1. There is no accumulation of fæcal matter near the cottages.

2. There is no dangerous conveyance of such matter for long distances either by pipe or any other means, and the land for burial being close at hand, the daily cleansing of these cottages is effected easily and quickly, the whole process not occupying more than an hour. For the success of this plan it is essential that the cottages should be in close proximity to the land. They cannot be too close, while every yard of porterage adds to the expense.

3. All nuisance has been absolutely stopped. The cottages are kept clean, and the garden where the fæcal matters are buried is not made in the least unpleasant. The material is placed immediately below the surface—*i.e.* it is just hidden by a layer of earth. The eye sees nothing and there is absolutely no odour. In fact, there is very much less annoyance than is caused by ordinary dungings and mulchings.

4. The 'sanitary arrangements' of the cottages being of the simplest, the incessant dribble of money for the repair of 'closets,' traps, syphon-bends, gullies, ventilator-pipes, &c., has ceased.

5. The fertility and beauty of the garden have been enormously increased, and its value, which was depreciated by its filthy surroundings, has probably rather more than recovered.

It may be well to state that the garden produces all the ordinary fruits and vegetables in a state of perfection which is clearly above the average. The improvement in its fertility has been steady and gradual from the beginning. When first occupied by the writer it had been neglected for about two years, and, as has been stated, it was so overgrown with weeds that the paths were scarcely recognisable.

The burning of the thick felt of weeds with which the ground was covered resulted in about a thousand bushels of ashes. To reduce this wilderness to a condition of decent tillage has necessarily taken time. Nothing, probably, has been of more assistance in this direction than the removal of the blockages in the 'little stream' and the consequent lowering of the level of the water. In the first year the garden was manured entirely with stable-dung, but since the acquisition of the cottages the only stable-dung which is allowed to come into the garden is a quantity sufficient to make a hot-bed in the spring.

For twenty-two years the garden was receiving the daily scavenging of twenty cottages with an average population of at least one hundred persons. The area actually under cultivation amounts (exclusive of paths and grass) to about $1\frac{1}{4}$ acre. Not only was the excremental matter from these cottages removed to the garden, but the ashes as well. On making a visit to one of the cottages one day the writer encountered an ash-heap close to the back door. The heap consisted of cinders, ashes, potato peelings and similar refuse, bits of paper, fish-bones, &c. The flies were buzzing over it, and it was distinctly malodorous. A woman who had been confined the day before was lying in the next house.

'What do you do with your ashes?' was the question asked.

'Oh, we sell them to Mr. So-and-so' (the higgler), was the reply.

'What does he give you for them?'

'A penny a bushel.'

'So will I, and I will provide you with a bushel measure to store them in, and when the measure is full they shall be removed and you shall be credited with a penny.' This plan has answered well. The ashes when received are carefully riddled through a sieve, and the cinders go a good way towards the maintenance of the greenhouse fire during the winter. The real ash is applied to the land, and has a most beneficial effect not only by providing mineral manure, but also by improving the physical condition of the soil. It is often stated that while 'wood ashes' are good for the land, 'coal ashes' are of small value, the reason of this distinction being caused by the confusion in the mind of the public between *cinders* and ashes. Cinders are of no use whatever as manure, and only serve to hinder tillage. There is nothing in coal *ash* which can do any harm and much that will do good, especially in close soils, to which the gritty particles of coal ash give a certain porosity.

I have said that this garden of 1¼ acre was manured with the refuse of about one hundred persons for some years, and it may be stated that, proceeding methodically, it took four years to go completely over the whole of the ground in cultivation. The observer was usually astonished at the small amount of excremental material which has to be dealt with, not more, usually, than will lie in a furrow ten or twelve feet in length made in the ground with a spade. Directly it is deposited in the furrow it is lightly covered, and there is an end for ever of any offence or any danger. The first crop taken off the land is always a succulent green crop of the cabbage

tribe, and the plants are dibbled in on the third day after the deposit. No other crops except cabbages seem to flourish in the fresh material, but the cabbages may be followed by potatoes, these by celery (planted between the rows), the celery by peas or beans, and these again by parsnips or carrots, without any fresh manuring, and with a most abundant yield. There is no doubt that this excremental refuse confers a fertility upon the soil which is not exhausted for years. I have been urged by some practical gardeners not to apply the material to the ground at once, but to store it in a heap with earth and ashes to allow it to 'ripen' before applying it. Those who give this advice have derived their experience from 'night soil' from privy pits which has undergone a certain amount of desiccation by the draining away of the fluid matter, and which is undoubtedly a most potent and dangerous manure when applied pure without previous admixture with earth and exposure to the air. By immediate burial before ammoniacal decomposition sets in there is no danger of this kind, and one is sure that nothing is lost. Further, if excrement be left above ground, blowflies and other insects will deposit eggs in it, and then the gardener will complain that 'closet-earth brings grubs,' but by immediate burial this drawback is avoided. Many practical gardeners who have seen the results of the plan of operations which has been described have admitted that the results could scarcely be better than they are.

Not only vegetables but all the ordinary garden fruits are produced in high perfection. A large contribution is always sent to the local flower show, the object being not so much to show single specimens of this or that forced to unnatural dimensions, but to demonstrate that the garden will produce every kind of

common flower, fruit, and vegetable in a condition above the average, and that sanitation may be both complete and profitable. (*See frontispiece.*)

It may be of interest if I state the amount which this garden has yielded since it was started in 1882. For the first year or so it was dependent upon stable manure, which cost about 5*s.* a load. Between 1882 and 1888, cottages were purchased until the full number of twenty was reached in the latter year. Two baskets per week of vegetables and fruit sent to London have been valued at 2*s.* 6*d.* each, or 13*l.* per annum. In addition, fruit and vegetables have been marketed, and the following are the sums actually received, the land in cultivation, be it remembered, being $1\frac{1}{8}$ acre before 1899 and $1\frac{1}{4}$ since that date.

	£	s.	d.
1888	29	10	2
1889	27	15	8
1890	34	14	6
1891	29	11	11
1892	28	14	4
1893	45	19	3
1894	50	0	0
1895	47	10	6
1896	57	6	10
1897	52	9	9
1898	71	19	6
1899	78	14	7
1900	91	2	11
1901	89	13	4
1902	58	4	9

The most satisfactory part about these figures is their almost uninterrupted increase. The great fall in 1902 was caused by the destruction of fruit by the late frosts.

The garden is well stocked now with fruit trees of all kinds, but, on the other hand, no inconsiderable part of it is given up to flower borders, which give no pecuniary return.

I have dwelt upon the quality and variety of produce from this garden of little more than an acre manured with the excremental and other refuse of one hundred persons, because in this respect it is in contrast with a 'sewage farm,' which, as is well known, can be made to produce practically nothing but rye-grass and mangel. In the garden there is no excess of fluid with the manure, and the careful hand tillage brings about the aeration of the humus, and thus the nitrification of the organic matter is quickly produced. If one had to deal with the same amount of excremental matter in the form of 'sewage' it would be accompanied by a daily quota of 1,000 or 1,500 gallons of water, a large proportion of which would have been previously boiled, and thus deprived of its oxygen and other gases. Under such circumstances proper tillage and nitrification is impossible, and the attempt to produce any crop other than rye-grass is labour in vain.

The following extract taken from Morse's 'Japanese Homes and their Surroundings' (London, Sampson Low & Co., 1886) cannot fail to be of interest :—

'It would be an affectation of false delicacy were no allusion to be made to the privy which in the Japanese house often receives a share of the artistic workman's attention. From its position in the house, and especially in the public house, it is often a source of great discomfort. In the better class of private houses in Japan, however, there is less annoyance and infinitely less danger from this source than is experienced in many houses of the wealthy in our great cities. In the country the privy is usually a little box-like affair removed from the house, the entrance closed half-way up by a swing door. In the city house of the better class it is at one corner of the house, usually at the end of the verandah,

and sometimes there are two at diagonal corners. A curious superstition among many is attached to the position of the privy in its relation to the house—a trace probably of the Chinese *Fungshui*. The privy generally has two compartments—the first one having a wooden or porcelain urinal; the latter form being called *asagaowa*, as it is supposed to resemble the flower of the morning glory—the word literally meaning morning face. The wooden ones are often filled with branches of spruce, which are frequently replenished. The inner compartment has a rectangular opening cut in the floor, and in the better class of privies this is provided with a cover having a long wooden handle. The woodwork about this opening is sometimes lacquered. Straw sandals or wooden clogs are often provided to be worn in this place.

'The interior of these apartments is usually simple, though sometimes presenting marvels of cabinet work. Much skill and taste are often displayed in the approaches and exterior finish of these places. . . . The receptacle in the privy consists of a half of an oil-barrel, or a large earthen vessel sunk in the ground, with convenient access to it from the outside. This is emptied every few days by men who have their regular routes; and as an illustration of the value of this material for agricultural purposes, I was told that in Hiroshima in the renting of the poorer tenement houses, if three persons occupied a room together the sewage paid the rent of one, and if five occupied the same room no rent was charged! Indeed, the immense value and importance of this material is so great to the Japanese farmer, who depends entirely upon it for the enrichment of his soil, that in the country personal conveniences for travellers are always arranged by the side of the road in the shape of buckets or half-barrels sunk in the ground.

'Judging by our standards of modesty in regard to these matters there would appear to be no evidence of delicacy among the Japanese respecting them ; or, to be more just, perhaps I should say that there is among them no affectation of false modesty—a feeling which seems to have developed among the English-speaking people more exclusively, and among some of them to such ridiculous heights of absurdity as often to be fraught with grave consequences. But among the Japanese it would seem as if the publicity given by them to the collection of this important fertiliser had dulled all sensitiveness on their part, if it ever existed, concerning this matter. Indeed, privacy in this matter is impossible, when it is considered that in cities—as in Tokio, for example—of nearly a million of inhabitants this material is carried off daily to the farms outside, the vessels in which it is conveyed being long cylindrical buckets borne by men and horses. If sensitive persons are offended by these conditions, they must admit that the secret of sewage disposal has been effectually solved by the Japanese for centuries, so that nothing goes to waste. And of equal importance, too, is it that of that class of diseases which scourge our communities as a result of our ineffectual efforts in disposing of sewage, the Japanese know but little. In the country there are no deep vaults with long accumulations contaminating the ground, or underground pipes conducting sewage to shallow bays and inlets, there to fester and vitiate the air and spread sickness and death.

'On the other hand, it must be admitted that their water-supply is very seriously affected by this sewage being washed into rivers and wells from the rice-fields where it is deposited ; and the scourge of cholera, which almost yearly spreads its desolating shadow over many

of their southern towns, is due to the almost universal cultivation of the land *by irrigation methods*;[1] and the consequent distribution of the sewage by these surface avenues renders it impossible to protect the water-supply from contamination.'

A word of caution needs to be uttered as to the *great harmfulness of antiseptics* from the agricultural point of view. Speaking broadly, it may be stated that any organic matter which has been mixed with chemical antiseptics or disinfectants becomes sterile and poisonous to plant life. In 'town sewage' there is always great danger to agriculture from the admixture of antiseptics, and the danger is not always to be avoided even when the 'pail system' is employed.

A town surveyor was recently contending with the writer that fresh excrement was not a good manure, and in support of this he instanced a failure on his part to grow mangel. The first year, he said, scarcely a seed sprouted, and even in the second year the crop was very stunted and miserable.

As, however, I elicited the fact that his material was mixed with a preparation of carbolic acid, the failure of his agriculture is not surprising.

If daily removal be resorted to, the admixture of antiseptics is unnecessary, and it cannot be too strongly insisted upon that any such mixture of antiseptics with manurial matters is fatal to any scheme for their utilisation.

In 1894 there were rumours of cholera, and various schemes for disinfection were put forward in the public

[1] The italics are not in the original, and are used by the author to draw attention to the well-known fact that rice-fields are frequently flooded, and that there are necessarily dangers connected with the use of excrement in rice cultivation which do not obtain in the case of crops which require a fairly dry soil.

press and elsewhere; it may not therefore be amiss to say a few words on the subject.

In dealing with all organic refuse we ought always to have before our eyes those processes which we may call 'natural,' whereby the organic matter is nitrified and transformed, and we should be careful to do nothing to hinder such processes. The admixture of organic refuse with antiseptics (whether salts of mercury or tar derivatives) hinders its ultimate dissolution by killing the microbes in the soil and in the organic matter itself. The admission of these antiseptics into sewers or cesspools renders the whole of the material in the cesspool or sewer a dangerous application for agricultural purposes. These antiseptic bodies, when used for disinfecting excremental matters, are often applied hastily, and there is no attempt to thoroughly mix the antiseptic with the material to be disinfected. These two are never allowed to remain long in contact, but the handle is pulled and away it goes to be diluted instantly to a degree which probably extinguishes its antiseptic power. Many of the antiseptic bodies (notably the mercurial salts) have the power of coagulating albumen, and it must be a question as to whether this action may not have occasionally a preservative effect on noxious microbes by causing spores to be hermetically sealed, as it were, in a case of coagulated albumen. If this be so, it is conceivable that antiseptics clumsily and perfunctorily used may actually preserve an infective particle. They will most certainly arrest the process of nitrification and dissolution in the earth whereby the noxious microbe is probably destroyed for ever.

The writer's opinion is that, if infective material be buried in the earth (without admixture with water or

antiseptics), it is hardly conceivable that any harm can result, and all evidence tends to show that the living humus will effectively protect the wells from infection (if these be properly made) by completely arresting the passage of microbes. The fact that chemical antiseptics often coagulate albuminous fluids, and are certainly fatal to the biological processes in the soil, is one which must be ever before the mind.

The safest disinfectant is heat, and it is the only one which, practically speaking, is always at hand. On the occurrence of a case of cholera in a rural district, I think the safest course would be to superficially bury all the excreta of the patient, and then wash the vessels and clothing in water gradually brought to the boiling-point, which water should ultimately be thrown upon the surface of the soil. The clothing and infected linen should be placed in a washing 'copper' with cold water and soda, and allowed to soak until the albuminous stains have been dissolved. The copper fire should be then lighted and the contents thoroughly boiled. To burn good linen because a cholera patient has used it seems to be at once needless and silly. In times of infective disease, the washing copper, intelligently used, is the best antiseptic, and the cheapest, because in this way the first stage of the laundry work is accomplished, and there is no bill for poisonous chemicals. Infected clothing should not be mixed with salts of mercury or carbolic acid, because the albuminous matter (blood, &c.) is thereby coagulated, and the proper cleansing of the clothes in the laundry is interfered with. Neither should linen be plunged into *boiling* water for the same reason, but, as advised, it should be allowed to soak for some hours in cold water and soda, whereby the albu-

minous stains are dissolved, and then be gradually boiled. If the actual boiling of the excreta of cholera patients could be arranged before being allowed to flow into the sewer, no more effectual process of disinfection could be conceived, although, without special precautions, such process would be necessarily offensive.

We constantly hear in the present day of the dangers arising from a 'foul soil,' and there are those who attribute many of the evils which come upon us in the form of disease to foulness of the soil.

It cannot be too strenuously asserted that there is only one sure and certain way of keeping the ground sweet—viz. by tillage, aëration, and cultivation of it. To pour antiseptics upon it, or to cover it with concrete, is no cure. These methods

> will but skin and film the ulcerous place,
> Whilst rank corruption, mining all within,
> Infects unseen.

If the soil be tilled, so that it brings forth trees or herbage with green leaves, the air will be freshened and purified by the oxygen given off by the leaves, and the soil itself will be cleansed from all impurities. It is a common mistake to bury offensive things too deeply. If organic matter be buried in the barren subsoil instead of the living earth of the upper strata, nitrification will be delayed, and the possibility of contamination of the neighbouring wells will be greater than when such material is buried superficially, and within reach of the husbandman's tillage.

In the burial of the dead the mistake has been made not only of hindering the dissolution of the body by every means that ignorance, superstition, and self-interest can suggest, but also by the fashion of burying too deeply.

The body should be laid in the humus and should be covered by a mound of earth, which in all cases should be planted with shrubs and trees suitable for the soil. If this be done, it is hardly conceivable that any poisonous or other organism can find its way to the wells.

CHAPTER X

PERSONAL EXPERIENCES AS TO WATER-SUPPLY

The water-supply of the writer's cottages is worthy of more than passing mention.

The house, garden, and cottages, as was stated in the previous chapter, are close to and only a very few feet above the level of the river Anton, and running parallel to the Anton is a tiny rivulet which may be called the 'little stream.' Those who have not seen them can hardly imagine the beauty of the Hampshire trout streams, with the rippling of clear sparkling water over waving weed and bright patches of gravel where the trout lie. Unfortunately there is no truer proverb than that 'familiarity breeds contempt,' and it certainly is true that the dwellers by the banks of the Anton, far from worshipping the river or even treating it with decency, seem to make every attempt to spoil its beauty and heap upon it every indignity. It is instructive on a bright summer's day to lean over the side of a boat and peer into the recesses in the bed of the Anton at points where the gardens of villas or cottages reach its banks. It is then that one realises what a pauperising thing is a running stream to those who are lazy and ignorant, how urgently our rivers stand in need of care, and how futile is the Pollution of Rivers Act!

In the bed of the Anton one may see, by peering to

the bottom, an old kitchen range, old iron buckets and pails innumerable, hoop iron, gas-pipe, bits of wire netting, old boots and shoes, broken bottles, crockery, old meat tins, the ribs of an umbrella, oyster-shells, and, in short, every conceivable kind of house-refuse. One only sees at the bottom a very small part of what is thrown into the river, the greater part having floated away down stream. The riparian owner or occupier keeps no dust-bin and he has no rubbish heap. He is absolutely ignorant of the right use of refuse, and throws everything into the river—dust, weeds, lawn-mowings, dead leaves, parings and trimmings of vegetables, prunings of trees, old gooseberry bushes, and finally his old garden tools and water-cans.

Under such conditions a river soon gets foul. The rubbish dams back the mud and it becomes difficult to keep the bed of the river clean. The weeds grow, and the beauty and utility of the stream are both reduced, while the thoughtless people who cause these obstructions are being deprived of material every scrap of which should be turned to profitable account. Bathing in such a river becomes unpleasant and dangerous, and boating, from the accumulation of weed, is no longer a pleasure. The trout cease to spawn when they can find no clear gravel for the purpose, and the millers complain that their head of water is seriously diminished.

'What are you going to do with that?' I said one day to a helper in the garden who was making for the river bank with a basket of weeds and rubbish in his hand.

'Chuck it in the river, sir,' was the reply.

'What would you do with it if there were no river?' was my next question, and this brought the man to his senses; and from that time I believe not a single weed or

any other refuse has been thrown from my garden into the Anton. The gardener carefully returns all rubbish to the soil either in the form of 'humus' or ash, because he recognises that low-lying gardens are much in need of replenishment, and that if everything be taken off his land and be thrown into the river the level of the soil will ultimately sink.

Is a running stream of no use to the agriculturist? River-mud is most certainly a valuable addition to light soils, especially those on the chalk, but before being applied to the land it should be allowed to 'ripen' in a heap with other rubbish. Applied direct it will choke the pores of the soil and do mischief. Again, is river-weed of no use as a manure? In Cornwall seaweed is rightly regarded as a most valuable manure, and it is certain that river-weed must have a similar though inferior value, and would do nothing but good to the light chalk soils of Hampshire.

At present a running stream is a pauperising medium to those who dwell upon its banks, instead of being of distinct value not only as a source of water and fish, but also of mud and weed suitable for putting on the land.

The recognition of the utility of a river by the agriculturist seems to be the surest road to its proper conservancy.

The above digression has been made to show the utter disregard of the average riparian for the purity of his stream. The smaller the stream, the less regard is had for it, and, as has been previously stated, the little stream running parallel to the Anton was utilised to receive the contents of w.c.s and house-slops until it became a veritable nuisance, was in great part covered in, got blocked, and ceased to act as an efficient drain for the land. The history of this rivulet was, in short, that

which is common to nearly all the rivulets in the country.

The surface wells for the supply of the cottages were close to the back doors, and being only a few feet deep it was customary to dip water out of them. The dipping utensils might be anything which was handiest, and might be clean or otherwise. The parapets of the wells were of wood (in places rotten) and only a few inches high, and the paving round them was a rough pitching of the worst description, generally sodden. An underground slop-drain, often blocked (the gratings of which had that odour which is called 'faint'), ran within a few inches of the wells, and finally the steyning or brick lining of the wells was very deficient.

Under the circumstances it appeared to the writer that it was incumbent upon him to 'lay on' water from the works of the Andover Water Company, which have since (as is the fashion of the day) been bought by the municipality and paid for by a bill on posterity. This water comes from a well about 90 ft. deep in the chalk, and had been pronounced of good quality. There might be fissures in this chalk well through which sewer or cesspool water might gain access to it, and the water might be contaminated by leakage from a sewer *en route* (no one could speak with certainty on this point), but the laying on of the municipal water relieved one of responsibility, and this probably was the chief reason for this course of action.

It has been mentioned how all the w.c.s were removed and how underground drains were replaced by open gutters, and there can be no doubt that the wholesomeness of the cottages has been enormously improved thereby. There is no longer any foul excremental matter in the 'little stream' (which receives only

house-slops), and there are no longer gratings emitting faint or foul odours at the back doors of the cottages.

It is often stated that as house-slops have to be got rid of, and as house-slops are very foul-smelling, it is the best course to construct an underground drain for their reception and allow it to carry off excremental matters as well. This is one of the chief arguments in favour of a comprehensive water-carried system. But there can be no doubt that the admission of excremental matters is the main cause of all the difficulties of the 'drainage' question, because when excremental matters are mixed with slops the mixture is so abhorrent to our senses that it *must be covered up*, and it is put underground in closed channels instead of being delivered upon the surface of the soil, in accordance with those true scientific principles which should guide us in these matters.

Now, as soon as all access of fæcal matter to the 'little stream' was stopped it became possible to open it in its entire length, to get rid of the accumulations of mud, and, as has been mentioned, to restore the proper drainage of the land under cultivation. The stream being open, any accidental arrest of the current is seen instantly and removed at once.

The stream receives the house-slops of twenty-three tenements, and I can state emphatically that this causes practically no annoyance. When a wash-tub is emptied there is a passing turbidity of the water, which quickly clears again, and there is an end of the matter. It would be perfectly easy to filter these slops through a bed of earth before allowing them to run into the stream, but they cause so little trouble or annoyance that I have not thought it necessary to do so as yet. It must be borne in mind that house-slops have been to a large extent boiled either in cooking or washing processes, and are

therefore mainly sterile and far less likely to contain noxious germs than are excremental matters. Their admission to a stream is not probably fraught with any danger to the riparians lower down. This stream is kept absolutely free from accumulation by ducks, which are allowed to work in it, and are most useful in stirring the bottom and keeping it bright. Ducks are very useful as scavengers. Although the house-slops which flow into this stream are as nothing when compared with the fæcal matter which formerly flowed into it, I am nevertheless of opinion that the sanitary authority should insist upon these slops passing through some filtering medium before being admitted to a public watercourse. Personally I should rejoice to receive such an order, because it would mean that the authority had been roused to a sense of its duty as to the protection of its natural water-supplies. Public authorities are ready to spend large sums of (borrowed) money on waterworks, but seldom show the least desire to really protect the purity of streams and rivers. As a matter of fact, the town river has not been 'dragged' for years, although this is a necessary process which has to be undergone by every stream which, like the Anton, is dammed at intervals by mills.

Thus far it will be observed the measures taken for the sanitary improvements of this small property have been (1) the abolition of all w.c.s and privy pits; (2) the daily committal of all excremental refuse to the earth; (3) the replacing of underground slop-drains by open gutters; and (4) the opening up of the 'little stream' and the removal of blockages.

The weak point in all these arrangements, which seemed like a standing reproach, was this, that, although the property was on the very brink of a sparkling river

which came welling out of the chalk hills, it was nevertheless advisable not to drink the local water but to obtain a supply from the water company. The shallow dip-wells close to the cottage doors were obviously so liable to contamination that, in spite of the repeated assurance of its being 'beautiful water,' common prudence made it imperative to get a supply from another source, and the 'laying on' of the municipal water was the safest and readiest plan.

The reader will scarcely need to be reminded that to 'lay on' water costs money, that the sum paid as 'water-rate' is not inconsiderable, that it has to be paid in the case of cottages by the landlord, and that it is not always easy to raise the rent in proportion. Again, cottages cannot be too simple in construction, and all sanitary fittings, including pipes, taps, &c., which are sure to be in constant need of repair, add to those expenses which the owner is bound to incur, whether he recover them or not from the tenant.

We all need to be reminded that if we, by ignorance or carelessness, foul the water which is beneath our feet, and have to bring water from a distance, the cost of living is thereby increased, rent must be higher, and less of the wages will be able to be spent in food, clothing, or luxuries, and that it is a most unthrifty arrangement for dwellers in a place where the potentialities of pure water are infinite to wilfully foul this water, and go to another source a mile distant, and 90 feet below the surface. The sum paid for water for the cottages was 8 per cent. of the gross rental in 1894, and the sum paid for rates and taxes was 14 per cent. of the gross rental. Since that date the municipality has purchased the waterworks and has lowered the charge to 6 per cent. at the expense of the district rate, which has risen considerably.

Shallow wells are universally regarded in these modern days as dangerous sources for water, and there can be no doubt that they are often contaminated, and have been a frequent cause of sickness.

How have they been contaminated? The answer to this is certain and most important. They have always been contaminated by direct inflow of filth from the surface of the ground in which they are dug, or by the leakage of cesspools or sewers direct into the well, through fissures in the soil and defect in construction.

The cause of the fouling of shallow wells is universally found in a neighbouring cesspool or sewer, in a collection of filth which has been mixed with water, and has been put into the barren subsoil, instead of being thrown upon the surface, to be dealt with by the fresh air and the living earth.

Since the adoption of subterraneous sewage methods, the fouling of the surface wells has become so common that it is now the fashion to condemn them. The wells have already had, so to say, to give way to the sewer. It has been the repetition of the wolf and the lamb of Æsop's fable—the sewer fouls the well, and therefore the well is abolished. This may be practical, but it is not logical or thrifty.

If the subterraneous collections of filth were abolished, and if our surface wells were properly constructed, we might drink of them with perfect safety; for it is well known that the filtration of water through a few feet of earth deprives it of organic matter with a completeness which is almost absolute.

I determined to try the experiment of making a shallow well in the centre of my own garden—a garden, be it remembered, which is rather highly manured with

human excrement. (A full description of this well will be found at p. 263 *et seq.*)

If filthy water were put upon the surface of the ground, all wells, deep or shallow, which were properly protected from surface drainage would be safe. If there be sewers or cesspools in the neighbourhood of a well, such well cannot be safe, be it shallow or deep. It cannot be too strongly insisted upon that the fouling of wells is due entirely to our unscientific methods of treating filth.

The only difficulty which has been experienced with the author's well is to keep insects out of it; spiders, wood-lice, earwigs &c. finding their way beneath the crevices of the lid, and this in spite of tarring the inside. This invasion by a few insects is unimportant from a sanitary point of view, but it obviously interferes with the value of any bacteriological examination. I am unwilling to seal the well up, because thereby I should lose the power of examination and inspection.

In conversation with Sir E. Frankland I explained the circumstances of this well to him, and he most kindly offered to make a chemical examination. I need hardly say that I accepted this kind offer, and accordingly, in April 1892, I sent a sample of water to him, and in due course received his analysis and report.

The latter was as follows:—

'This water contains a large amount of saline matters in solution and is very hard.

'It is *organically very pure*' (the italics are my own), 'but it exhibits strong evidence of having been in contact with animal matter (previous animal contamination), and would on this account be condemned for dietetic use.'

This letter was accompanied by a printed circular, of

which it is necessary to give one paragraph, that the reader may fully comprehend the whole question :—

'The column headed "Previous Sewage or Animal Contamination" in the accompanying analytical table expresses, in terms of average London sewage, the amount of animal matter with which 100,000 lb. of such water was, at some time or other, contaminated. Thus 100,000 lb. of the water of a shallow well at Andover had been polluted with an amount of animal matter equal to that contained in 5,100 lb. of average London sewage. So far as chemical analysis can show, the whole of this animal matter had been oxidised and converted into mineral and innocuous compounds at the time the analysis was made; there is, however, always a risk lest some portion (not detectable by chemical or microscopical analysis) of the noxious constituents of the original animal matters should have escaped that decomposition which has resolved the remainder into innocuous mineral compounds. But this evidence of previous contamination implies much more risk, when it occurs in water from rivers and shallow wells, than when it is met with in the water of deep wells or of deep-seated springs.'

That the water was *organically very pure* was highly satisfactory, and its condemnation for dietetic purposes no more than was to be expected, and Sir E. Frankland clearly could not avoid condemning such water taken, as he had been informed, from a shallow well in the centre of a garden which received large quantities of human excrement.

From the above document, however, it is clear that the well was condemned on account of its shallowness and situation, and not on the merits of the analysis. It is the almost invariable custom of analysts to condemn such water, but, nevertheless, I should have no hesitation

in using the water of this particular well, (1) because it is easy of complete inspection, (2) because there is neither sewer nor cesspool within reach of it, and (3) because the water is bright and palatable and is pronounced as 'organically very pure.'

For the purposes of the argument three analyses made by Sir E. Frankland have been placed in juxtaposition.

The first is that of water taken from a deep well belonging to the Kent Water Company.

The second is from the shallow well in the author's garden at Andover.

The third is from the deep well formerly belonging to the water company at Andover.

The first of these waters is praised for its excellent quality and very high degree of organic purity; the second, though 'organically very pure,' is condemned as unfit for dietetic use; while the third is of 'excellent quality for dietetic purposes,' and 'well suited for the supply of a town.'

A close examination of the figures shows that the third water is probably the best, notwithstanding its 'slight turbidity' and its relatively larger amounts of organic carbon and organic nitrogen. The other two waters (the deep Kent and shallow Andover) are not at all unlike in composition, and examination of the figures only would render it difficult to say which was the better.

This term, 'previous sewage or animal contamination,' seems to me rather a misleading one (not to say terrifying). The surface of the earth is the common receptacle of dead organic matter of all kinds, and rain passing through the upper layers of the soil *must dissolve* the nitrates which are formed *in these upper layers* and carry them through to the deeper ones. For the purpose

Three Analyses of Water by Sir E. Frankland, with Remarks.

In parts per 100,000

	Total solid matter	Organic carbon	Organic nitrogen	Ammonia	N. as nitrates and nitrites	Total combined N.	Previous sewage or animal contamination	Chlorine	Total hardness
[1] Deep Well of the Kent Company. June 23, 1892	40·80	·038	·010	0	·494	·504	4,620[2]	2·4	28·4
[3] Shallow Well, Andover. Apr. 1892	37·60	·054	·008	0	·542	·550	5,100	1·9	27·8
[4] Deep Well, Andover. June 12, 1875	28 28	·106	·031	0	·444	·475	4,120	1·25	22·1

[1] 'Excellent quality for dietetic use.' 'Especially distinguished for its very high degree of organic purity.' (Report to Registrar-General, June 30, 1892.)

[2] This figure is not given by Sir E. Frankland, but has been calculated by the Author from the amount of N. as nitrates and nitrites.

[3] 'Clear. Organically very pure, but it exhibits strong evidence of having been in contact with animal matter (previous animal contamination), and would on this account be condemned as unfit for dietetic use.' (Letter to the Author, May 13, 1892.)

[4] 'Slightly turbid, wholesome, palatable, and of excellent quality for dietetic purposes. As it is derived from a deep well, the evidence of previous animal contamination which it exhibits may be safely disregarded. The hardness is rather less than that of chalk waters generally. It is well suited for the supply of a town.' (Letter to the Secretary of Andover Water Company, June 12, 1875.)

of converting organic matters into nitrates the first few inches of the soil (owing to the access of air and a plentiful supply of microbes) is of more value than all the rest, and if filthy water escape the action of the upper layers it may travel for any distance without being nitrified.

The nitrifying power of the soil increases apparently with cultivation, and there is good reason to believe that the nitrifying power of humus is proportioned to the degree of high cultivation to which it is brought. If, however, filthy water be allowed to escape the action of the upper actively nitrifying layers, and be conducted by pipes beyond the reach of them, as is the unscientific

custom of to-day, it is very doubtful if proper nitrification is ever attained. The nitrates in solution show that organic matter has been nitrified and rendered harmless, and it is difficult to understand why they should be a sign of danger in shallow wells and lose such significance in deeper wells, notwithstanding the fact that the deeper layers of the earth have but little action on organic matter. If dangerous filthy water has managed to leak five feet through the earth without undergoing any nitrification, it would experience no difficulty in trickling in the same condition for the next 500 or 1,000 feet, and the deeper it gets, the less likelihood is there of nitrification taking place.

While, undoubtedly, we want evidence of *present* sewage contamination, it is difficult to see the bearing upon dietetic value of *previous* sewage contamination. The fact that saltpetre owes its origin to the fermentations of a dung-heap in no way affects its wholesomeness.

The water of my Andover garden well was subjected to analysis for the Royal Commission on Sewage Disposal in 1902. This analysis was identical with Frankland's. There were no nitrites, showing that the oxidation of organic matter was complete.

To go back to the lesson which is taught by this garden at Andover. The excrement of over 100 people is buried daily in little more than an acre of ground, with horticultural results distinctly above the average. The slop-water runs in *open* gutters to an *open* stream; there is not a single underground sewer-pipe, drainage-pipe, or cesspool upon the premises. A shallow well sunk in the centre of the garden yields water which is 'organically very pure,' and which, personally, I should not fear to use for dietetic purposes.

Here we have the complete circle of changes—the right use of refuse leading to the profitable production of food without causing any danger to the water. In low-lying villages the best source of water is probably to be found in *properly constructed* surface wells, provided there be no sewers or cesspools, and slops run in *open* channels on the surface of the ground, and, of course, away from the wells.

In the 'Annual Summary of Births, Deaths, and Causes of Death in London and other Great Towns, 1893,' Sir E. Frankland makes some most interesting remarks on the condition of the London water-supply. Sir E. Frankland's observations in 1893 are strongly confirmatory of analogous observations made in Germany (by Koch and others) and in America (by the Massachusetts Board of Health), that the purification of foul liquids by filtration is a biological process and not a merely mechanical process. Sir E. Frankland's bacteriological observations show that a cubic centimetre of Thames water before filtration contains (on an average for the year) some 5,000 microbes; the maxima occurring in February and October, when the river was in flood, when the number exceeded 13,000. Downward filtration through sand removed, on an average, 98 per cent. of the contained microbes, so that the water delivered to the houses was in a condition of considerable bacterial purity.

Sir E. Frankland adopts unreservedly the views put forward by Koch that the bacterial efficiency of sand-filtration depends, to a very large extent, upon the formation of a thin film upon the surface of the sand, derived from subsidence of suspended particles in the raw water supplied to the filters. This film forms a nidus for, and becomes thickly populated with, microbes which, in all probability, aid materially in the purification of the water

passing through the filter. This filter should therefore be renewed as seldom as possible, consistent with the passage of sufficient water through the filter. New filters and thoroughly washed filters are very ineffective for a considerable time.

Further, the efficiency of sand-filtration does not seem to depend upon the thickness of the sand-filters. Water which had passed through filters a little over two feet in thickness was as free from bacteria as that which had passed through filters of twice the thickness. It seems important, however, that the rate of filtration should be uniform and that the maximum rate should not exceed four inches or about two gallons per hour per square foot of surface.

The fact that the purification of water is effected by a living film on the top of the filters is calculated to impress one with the potency, to this end, of the 'living earth' with which we are fortunately on all sides surrounded, and must cause us to reconsider the value of surface wells, provided these be properly protected from surface contamination.

During the year 1893, the Southwark Water Company drew some of its supply 'from the gravel flanking the Thames near the company's works at Hampton,' and the result of the bacterioscopic examination of this water by Sir E. Frankland is most interesting. In February 1893, when the raw Thames water contained 13,947 microbes per c.c., the water pumped from the gravel contained only twenty microbes per c.c. On the 4th of February three filters belonging to the Southwark Company had been supplied for four days with gravel water exclusively, and it was found that, whereas the gravel water as it flowed on to the three filters contained only twenty microbes per c.c., the effluent water from the three

filters contained 66, 62, and 54 microbes per c.c. respectively.

It is not only the vital and biological condition of humus which makes it such a good filter, but its mechanical condition also. Well-tilled humus is loose, porous, and crumbly, and it is not liable to have dangerous cracks or fissures formed in it as the result of drought and heavy rain. The surface of well-tilled land soon adjusts itself to the pressure of water falling upon it, and it is hardly conceivable that filth can make a 'short cut' into a well properly made and with cultivated surroundings. The best surrounding for a well is probably turf, and the next best is *well-tilled* humus.

No well, be it deep or shallow, can be always safe unless it is properly looked after and receives intelligent attention. The old-fashioned dip-well, without parapet, surrounded by coarse pitching and sour-smelling puddles, where filthy water is thrown day after day, must get fouled, and those who drink of it do not deserve to escape the penalties of their neglectful carelessness.

It is very important that the waste water from a well be conducted to a safe distance. The constant drip of water *in the same place* day after day is sure to wear a channel along the course of pipes or brickwork, and in this way a short cut by which filth may reach the well will certainly in course of time be made. It is the constant delivery of liquid filth day after day in the same place which constitutes the danger of cesspools and sewers, for directly a leakage is made it is bound to travel steadily along the path of least resistance. Those who wish to be safely guarded against leakages of this kind must be careful never to throw their slop-water for many days together in the same place. In sewers and cesspools we are apt to get a column of water capable of

exercising no little pressure, which, of course, increases the danger from leakage almost infinitely. It must never be forgotten that filth in a cesspool underground and filth deposited on the surface of the ground are in totally different conditions, both vital and physical. On the surface those chemical and biological processes which constitute our protection are forwarded, and the dangerous pressure of a column of water is impossible. In a cesspool nitrification is delayed, and it is almost certain that sooner or later the pressure of the fluid will cause an irruption which must in time worm a passage to the nearest water source.

CHAPTER XI

PERSONAL EXPERIENCES IN A LONDON SUBURB

In the year 1887 the writer supplemented his professional residence with a country cottage in a suburb in the Thames Valley.

The cottage selected was a 'villa,' of the commonest cockney type, abominably planned and abominably built, but not much worse than its neighbours. The attraction lay in the fact that all its windows looked south or east; that from its windows one commanded a view of an attractive rural district; and that the villa had a garden of a quarter of an acre, very picturesque and well exposed to the sun.

This little house drew its water from a private well, and drained through a grating in the ground which presumably took the sewage somewhere, but no one could tell where that somewhere was, and no little difficulty was experienced in finding the inevitable cesspool. The w.c., wedged into a recess close to the kitchen door, was absolutely dark and without ventilation, except into the house. Although this house was not the author's property, the owner allowed him to carry out his ideas and so rearrange matters that all refuse should be returned to the soil without the intervention of sewer or

cesspool. It must be remembered that the design of the house was, so to say, a fixed quantity, bad but unalterable, and the plans adopted were merely make-shifts, and such as proved feasible under the circumstances.

The old w.c. was routed out with its pan, levers, cistern, and pipes, and the cesspool was emptied and abolished. An E.C. was erected just beyond the limits of the house. The contents of the E.C. were buried every day just beneath the surface, and thus the question of excrement disposal was easily settled.

Next as to the bestowal of slops: (*a*) kitchen-slops, (*b*) bedroom-slops (soapy water and urine), and (*c*) the waste of a big fixed bath holding about thirty gallons.

The kitchen sink was so placed that its waste-pipe could not reach the outside of the house without being placed beneath the floor, and therefore the receptacle for this waste had to be sunk in the ground. A galvanised iron 'copper' with spherical bottom was used for this purpose, and this was emptied every day and put to the shrubs or wherever it was wanted. This was done by the lad who cleaned the boots, &c., and took four minutes at the most. It was done by a succession of lads, and no difficulty ever arose. There was no smell, nor unsightly appearance, and the waste water proved very fertilising. At intervals the receptacle for the kitchen-slops was scoured and polished with sand-paper. If it had been possible to obtain a fall for the kitchen waste, it might have been feasible to empty it by turning a tap instead of by a dipper, and thus some time would have been saved; but in practice the necessity of dipping proved to be no hindrance to efficiency, and the shape of the receiver lent itself to cleanliness. Experience leads one to say that kitchen-slops should

always receive independent treatment. Of all the household-slops they are infinitely the most concentrated, and contain a large amount of grease and suspended matter, so that in arranging for their disposal the constant shifting of the spot on which they are deposited is of importance, and it is advisable to strain them through a basket containing a wisp of straw.

For the disposal of the bedroom-slops the following method was adopted: A sink was placed outside one of the upper windows. This sink had the appearance of, and was indistinguishable from, a flower-box, and was, in fact, used as such. From this descended a 1½-in. zinc pipe (*without trap of any kind*) on to the surface of the soil, the total fall being about eleven or twelve feet. This pipe was freely exposed to the air in its entire length, and passed across the roof of an outhouse to reach its destination on the ground. The slops were received on an ordinary garden bed at the foot of a privet hedge. The soil is a stiff loam lying over brick earth. The whole arrangement was experimental, and was done with the roughest materials, because the writer felt he had his experience to gain, and as his possible failures would have to be paid for by himself, and not by his brother-ratepayers, he moved with caution.

There has been no trouble of any kind with this simple arrangement, no smell, no sloppiness; and during the severe winter of 1890-91 the slop-water ran away and soaked into the earth with as much readiness as it does at midsummer. There are no traps, and, the fall being considerable, water cannot freeze in the pipe; with the pipes arranged outside the house, it is impossible to have any 'traps,' and that is a distinct gain. The whole arrangement was soon covered with creepers and hidden from view.

A similar plan was adopted with the waste of the fixed bath. A zinc pipe (without traps) was conducted, by means of a rustic ornamental arch, across the path surrounding the house, and this delivered on to the surface of the ground and poured the water into a gutter scraped in the soil with a hoe, and running through a bed of shrubs (privet, hollies, yew, aucubas, and laurels). The gutter required occasional clearing with a hoe or rake, and the shrubs nearest the water needed more pruning than their neighbours, but no trouble ever arose with this simple contrivance, which is in the front of the house, a few feet from the parlour window, and between it and the road. The soil is a thirsty one, and when the plug of the bath was pulled up the gutter filled, and two minutes later the thirsty earth had sucked up every particle of the water. This gutter was about fifteen feet in length.

When this arrangement was planned, I was warned that soapsuds and urine was a combination so prone to foulness, that it would be impossible to treat it above ground. More than one distinguished sanitarian has visited the author's cottage and has applied his nose to the sink upstairs and the gutter in the garden, with the verdict that both are absolutely and perfectly sweet. The reason of this is that there is free access of air and no stagnation. While experimenting on the immediate filtration of bedroom-slops I tried an arrangement which necessitated some stagnation, and immediately the mixture became foul. A trap which is an arrangement for causing stagnation is always liable to be foul. As both ends of my waste-pipe terminate in the open air, no traps are necessary; and as a trap is merely a cesspool in miniature, this is a great gain.

This is a very simple history of a common cockney

villa, such as a clerk with 300*l.* or 400*l.* a year might very well occupy, and of which there are thousands in this district. It was rated at 38*l.*, and the whole of its bedroom-slops were disposed of in two gutters, while the kitchen-slops were given to the shrubs, which made a brave show in consequence in the summer. Of the quarter of an acre of garden only a very few square yards were absolutely needed for refuse utilisation and disposal, and if the material to be used had been ten or twenty times as great there would have been no difficulty. We habitually drank the water from the surface well, which, although hard, ran no risk of contamination. For the fixed bath we had the water of the Grand Junction Company, in order to save the necessity of a special cistern and the labour of pumping.

The arrangements which have been described are very simple, but simple as they are they require some attention in the way of clearing away dead leaves or other debris which may arrest the current of the water. If anything goes amiss with these simple contrivances it becomes evident instantly, and a rake or garden trowel is the only implement necessary for rectification. To persons who have grass-land and who keep a big staff of servants the disposal of house-slops can cause no difficulty. I have been at some pains to show how there is no difficulty in houses of the most modest type.

It was some satisfaction to feel that one lived in a house without sewer or cesspool and with no putrefying collections of filth beneath the surface of the ground. It was some satisfaction to feel that the refuse of the house was neither a source of annoyance to oneself nor of danger to one's neighbour, to feel that there was one house at least in the district (how many more were there?) which sent no filthy water to the river, and the sanitation of

which was no expense to the ratepayers and a profit to the occupier.

The reader needs to be informed, however, that he has very little liberty in sanitary matters, and that it is dangerous to spend much money upon any system unless it be that particular system which happens to be in fashion and which has received the sanction of the local authorities, and which the local authorities have power to *compel* one to adopt.

The suburban district in which the writer's cottage was situated contained 26,000 inhabitants and 7,000 acres of land; the chief industry was market-gardening, and there were very few houses without gardens or ample curtilage. Of course the district fouled the Thames. People had been permitted to send their filth into the Thames, and it is noteworthy that about the worst offender in this respect was a large building estate covered with high-class houses, and enclosed by gates and fences and which had retained its autonomy with regard to its roads. Why this wealthy estate should not have been compelled to deal with its own filth it is difficult to conceive. To have done so would have been easy, because the filth was not mixed with trade refuse of any kind.

But such matters nowadays are never dealt with piecemeal, and the ratepayer gets imbued with the notion that, although he is too lazy or ignorant to deal with his own small amount of refuse satisfactorily, he and his fellow-ratepayers will be able to deal satisfactorily with any amount when their heads are put together and they become a 'board.'

They have only to cast their eyes at London and many places in the neighbourhood to know how insuperable are the difficulties of dealing with sewage on a large scale, how insurmountable are the chemical diffi-

culties, and how well-nigh impossible it is to get the engineering arrangements (which are mainly out of sight) properly carried out by the contractors.

However, it goes without saying that this district adopted a large sewage scheme which involved the taking of pipes in many instances along hundreds of yards of road in order to reach the doors of houses standing in isolated positions and surrounded by acres of market-garden ground. The roads were soon 'up' for the sewers, and eventually miles of pipes were laid and 'sewage works' were erected, the whole costing, so it is said, about 120,000*l*. The figure is doubtful, because the author does not remember ever receiving a detailed statement of the cost in which the ratepayers had been involved.

It may be well to state that the *raison d'être* of these huge works was not the improvement of the public health of the district, but merely the stopping of the pollution of the Thames. The thing was done, and the domestic refuse of 26,000 people was mixed with the trade refuse of the district, including the waste from a big brewery, a dye-works, and a soap-works, and this was taken to one spot.

'What are you going to do with your sewage?' I asked of a local magnate one day in the train.

'A process,' was the reply.

'Which?' I asked.

'Oh, I don't know; there's hundreds of 'em.'

This answer probably gives a fair idea of the knowledge of the sewage question which is possessed by the average councillor, who merely sees that a great scheme is 'good for trade,' and especially good for the jerry-builder, who invariably follows a line of sewers. The 'process' adopted in this instance was precipitation by

means of alum and iron salts, and the success of it may be judged of by the following extract from the local paper for July 16, 1892 :—

'LOCAL BOARD.

'An ordinary meeting of the Board was held at the Town Hall on Tuesday. . . .

'*The effluent discharge difficulty.*—Mr. J. C. M., a resident of E— Road, protested against the discharge of effluent into the Old River, which flows at the edge of his property. He urged that something should be done immediately to remedy the nuisance, and stated that when he bought the property he was wholly influenced to purchase by the fact of the river being well stocked with fish—affording sport and pleasure. Being very partial to aquatics, he purchased a boat, and built a slip and boathouse, looking forward for some amusement in the future. But since the effluent from the Board's sewer works had been discharged into the river the fish had been driven away or poisoned by the chemicals in the liquor, which was so polluted and disgusting that it made one ill to see it, and the smell was intolerable. He asked the Board to restore the river to its original purity; otherwise he was compelled to dispose of his property under forced sale and remove from the locality, and he would have to call upon the local authority to recoup any loss he may sustain thereby.—Mr. E. said he fully confirmed the statement of the letter. The nuisance was really fearful. Last week the smell was very bad, and the water was extensively polluted. Sometimes that discharge was of a pure and satisfactory nature, but at other times it was directly the opposite. Mr. M. having remarked that the matter was receiving careful consideration, the matter dropped.'

The local board had adopted the 'separate' system and a precipitation process aided by chemicals, and already they were in difficulties, and it was an open secret that an inspector from the Local Government Board had condemned their effluent, which was as described in the above cutting.

Their action had so far resulted in an increased pollution of the river, and notwithstanding that they had more sewage than they could deal with they were asking for more.

On June 16 a peremptory 'notice to drain house' was received, in which 'We the Local Board' informed us that our house was 'without a sufficient drain,' and required us to make two covered drains (one for foul water and one for rain-water) within two months.

This notice was accompanied by a lengthy schedule of 'Regulations for House Connexions with Sewers and House-Drainage,' which in twenty-two long paragraphs prescribed the exact manner in which every detail of the work was to be executed.

At the time this notice was received no inspection of the house had been made, so that the knowledge possessed by the 'board' as to our insufficient drainage must have been intuitive.

These regulations showed conclusively how arbitrary is the power possessed by any local authority, and how great is the expense to the householder (in addition to the increase of rates) of complying with the requirements. These requirements also amply account for the popularity of 'sewage schemes' among builders, plumbers, the proprietors of patent pipes and varnishes, and also among water companies, for be it observed that the adoption of water-closets makes one dependent upon a water company for cleanliness. The whole regulations

were remarkable for their precise directions for wasting rain-water, and contained no single word as to its storage. The document was also remarkable in so much as an earth-closet was not even mentioned as a possible alternative for the system proposed; notwithstanding that every E.C. erected would save the Thames from pollution and tend to lessen the difficulties into which the ratepayers have been run by the 'board.'

The documents revealed to the householder what a 'sewage scheme' means, and how with its adoption the Englishman's house ceases to be his castle and becomes a mere profitable plaything for patentees.

As some protection against Local Boards it may be well to give Section 37 of the 'Public Health Act of 1875,' which is as follows: –

'*Any enactment in force within the district of any local authority requiring the construction of a water-closet shall be deemed to be satisfied by the construction, with the approval of the local authority, of an earth-closet.*'

The name of the board has been suppressed because the writer is well aware that its actions are largely controlled by higher authorities; and the actions of this particular board do not differ materially from those of others. The facts are given merely as types of what is common. The writer has no complaint against individuals, and he gratefully admits that, except in sending a peremptory order to foul the Thames, the action of the board towards himself has been reasonable and considerate. In answer to the above circular the board was informed of the arrangements which have been described; an official visited the premises, and having assured himself that we neither polluted the Thames nor annoyed our neighbours, and that we were not poisoning ourselves,

he appeared to be satisfied, and no further action was taken.

This cottage was probably the only one in the group of fifty houses to which it belonged that was without sewer or cesspool, and positively did not endanger the Thames. It would, however, have been quite feasible for all the others to have adopted similar measures, and many probably would have done so but for the compulsory power of the board, which makes occupiers chary of spending money upon arrangements which the board has the legal right to destroy, and then further compel the householder to spend money not as he fancies, but as 'We the Board' order.

Then, again, people think that, as they pay the rates, and as the sewers are in any case an expense to them, they may as well connect; and they are further stimulated by the thought that obedience to the board is the readiest road to peace and quiet, and as for the 'effluent,' that is an affair of the board, the Thames Conservancy, and the Local Government Board to settle between them. It is not (but it ought to be) a matter which concerns the individual.

The above little history has shown how a great sewage scheme was undertaken to save the Thames from pollution, and how the pollution was worse than ever when the scheme was finished. It also shows that at a time when the 'board' was in trouble about its effluent, and was receiving more sewage than could be satisfactorily treated by its existing plant, it was nevertheless serving peremptory notices upon householders which could have but one effect, viz. the increase of its own difficulties. It need hardly be said that the usual complaints were being made about the smells from sewer gratings, &c., and the inevitable question of 'ventilation' cropped up.

Indeed it may safely be predicted that the sewage difficulties of this district, so far from being ended, have only just begun, notwithstanding an expenditure (both public and private) which cannot be far short of a quarter of a million of money, or nearly 10*l.* per head of population.

The poor are apt to fancy, when they see the streets and roads blocked by 'works,' that it is good for trade, and they do not stop to think that possibly money which might go into their pockets is being sent out of the district for the purchase of patent pipes, machinery and chemicals, and that the work itself is largely executed by labourers imported by the contractor. These schemes are thoroughly bad for the labouring classes, because they seek to do by mechanical means that which can only be done efficiently piecemeal and by the aid of hand labour. Such schemes starve the ground and cause less money to be spent in cultivating the soil and in harvesting crops.

A quarter of a million of money (the sum probably spent by the 26,000 persons of the district) at 3 per cent. will yield 7,500*l.* per annum, or enough to pay good weekly wages *all the year round* to 150 extra scavengers, and the wages of the staff, the cost of maintenance and the sums paid for chemicals, would probably support fifty additional scavengers. There can be no doubt that, from the point of view of employment for the poor and the provision of work all the year round, these big schemes are thoroughly bad. And, further, there is no doubt that, if the sums spent on pipes and machinery (public and private) had been sunk for the provision of extra labour, the Thames would have been saved from pollution, there would have been no annoyance, and a profit would have been made. Most certainly the poor labourer and those who are anxious to provide constant employment for the working classes should in no case support

big sewage schemes, which rob them of work. If the sums raised by 'rates' be spent in the district not much harm will result, and rates spent in labour will probably save the 'poor-rate.' But if huge sums be spent upon imported machinery which is erected by labour which is also often imported, and if such machinery and plant lead to the employment of less local labour and the starving of the soil of the district, then it is evident that big sewage schemes, which are bad for every one (except the landowner, jerry-builder, and water-shareholder), are especially bad for the poor. Even if the scheme be entirely carried out by local labour and home-manufactured materials, the gain is only transient, and we have to consider the relative advantages of spasmodic *versus* permanent employment.

Refuse, if properly used, is a source of food and wages, but if improperly used it merely leads to waste and starvation. That is a fact which the poor man has to bear in mind when he votes at municipal elections.

It will be profitable to consider the financial aspect a little more in detail. The rateable value of the writer's cottage was, as has been stated, 38*l.*, reduced to 34*l.* in 1900, and for the first half-year of residence (1887) the rates were: district-rate, 1*l.* 18*s.*; poor-rate, 1*l.* 18*s.*; burial-rate, 6*s.* 4*d.*; or a total of 4*l.* 2*s.* 4*d.* (8*l.* 4*s.* 8*d.* for the year).

Since then the rates have gradually crept up, and for the last *half*-year of 1892 the amount was: district-rate, 3*l.* 16*s.*; poor-rate, 2*l.* 4*s.* 4*d.*; burial-rate, 6*s.* 4*d.*; giving a total of 6*l.* 6*s.* 8*d.* (12*l.* 18*s.* 4*d.* for the year). Thus in five years the rates had risen 53 per cent. This demand note issued by the District Board contains some information concerning the details of expenditure &c, which is worth recording:—

ESTIMATED RECEIPTS AND EXPENDITURE

For the Half-year ending March 25, 1893

LIABILITIES

	£	s.	d.	£	s.	d.	£	s.	d.
Salaries				892	6	0			
Establishment				250	0	0			
Works Committee, Estimate:									
Lighting and highways	7,400	0	0						
Sewage disposal works	1,054	0	0						
				8,454	0	0			
Fire brigade				600	0	0			
Hospital				150	0	0			
Loans, interest, and repayments				3,013	8	4			
Sundries (including creditors)				2,600	0	0			
							15,959	14	4

ASSETS

	£	s.	d.	£	s.	d.
Balances	398	6	0			
Arrears of rate	860	0	0			
County Council (main roads)	3,287	10	0			
Miscellaneous	652	11	8			
				5,198	7	8
To be provided				10,761	6	8

The rate demanded is two shillings in the pound.

It is to be noticed that the County Council provides 3,287*l.*, an asset which was non-existent in 1887, when the rate levied was a shilling only. If the District Board had to collect this sum for themselves it would raise the demand to 2*s.* 7½*d.* or 2*s.* 8*d.* in the pound. This windfall from the County Council might, but for the large expenditure on sewers, have reduced the shilling rate of 1887 to one of fivepence only, and instead of a demand for 3*l.* 16*s.* for the half-year, one of 15*s.* 10*d.* only would have had to be made. As it is, the County Council money merely saves the board from having to demand 4*l.* 18*s.* 2*d.* instead of 3*l.* 16*s.*, and serves

mischievously to mask their extravagance. We have said that the total yearly rates levied on a 38*l.* house amount to 12*l.* 19*s.* 4*d.* But if we reckon in the County Council money (which in fairness ought to be reckoned), and if to this be added the inhabited house duty (1*l.* 2*s.* 6*d.*), income-tax (1*l.* 2*s.* 6*d.*), and tithe (3*s.* 10*d.*), it will be seen that the real charges on this house amount to 17*l.* 6*s.* 6*d.* Notwithstanding this high figure, it is said that we ought to be thankful because we have some well-endowed schools, and are saved a school board rate, which (judging by London experience) would very soon run up the charges on the house to 19*l.* or 20*l.*

Again, it must be remembered that with a compulsory system of sewerage (and compulsory w.c.) there is practically a compulsory water-rate which (with a 38*l.* house) amounts to 2*l.* irrespective of the amount of water used.

We have thus arrived at the conclusion that, although the actual charges in this particular instance amount to only 17*l.* 6*s.* 6*d.* (reckoning the County Council money), we ought nevertheless to be thankful, and that the average villa-holder in a London suburb may think himself extremely lucky if the obligatory charges on his house amount to less than 50*l.* per cent. of the rental. The clerk on 400*l.* a year who takes a 40*l.* villa in the suburbs must remember that the total outgoing for his house will really amount to 60*l.*, and that in these days he will not only have to pay income-tax, but a special local taxation as well, which will not improbably amount to 5 per cent. of his total income.

We are constantly being threatened with an increased poor-rate to find work for 'the unemployed.' Time out of mind the work of scavenging has been done by the

class just above pauperism. We are spending 6,000*l.* a year in a futile attempt to get our scavenging done automatically; we are robbing the lowest class of what may be regarded as their legitimate employment, and as a natural consequence we are being called upon to keep them.

My connexion with the Thames Valley came to an end in 1902, and it will be of interest to compare the rate (district &c. and poor-rate) of the initial and final years.

1887	£	s.	d.
District-rate	3	16	0
Poor-rate	4	2	4
Total	7	18	4

A few years ago the rateable value of the house was lowered from 38*l.* to 34*l.* In 1901–2 the sums paid for the lower valuation were –

	£	s.	d.
District-rate	7	18	8
Poor-rate	6	13	2
Total	14	11	10

This amounts to 8*s.* 7*d.* in the pound on the rateable value as against 4*s.* 2*d.* in 1887.

The cause of this increased rate is made clear in the financial statement for the year ending March 31, 1899, wherein the auditor certifies a total expenditure of 54,446*l.* 3*s.* 4*d.*, a sum which is not far off 2*l.* per head of population. Of this sum 20,400*l.* was raised by loans, and the balance from other sources of revenue, including 20,127*l.* from the district-rate.

Of this expenditure the following items are of interest:—

	£
Salaries and establishment charges	2,251
Sewage—current expenses	4,283
Sewerage works (borrowed)	5,594
Interest and repayment of loans, of which about two-thirds were raised for sewerage works	9,025
Maintenance and repair of roads	11,033
Streets and paths (loans)	3,571
Stock expenses and interest for overdraft	629
Private improvement works	9,402

The main sources of finance, other than rates, were—

	£
Private improvement works	11,220
County Council	7,693
London United Tramways	5,000
Loans	22,403

The assessable value of the district for the year was 115,008*l.*

The amount of loans remaining unpaid was 125,878*l.* The Council began its career of borrowing in 1877, when it raised a loan of 1,500*l.* for the purchase of a gravel-pit. Then, after an interval of six years, in 1883 it borrowed 8,200*l.* to purchase a recreation ground. In 1886 it raised 77,000*l.* for works of sewerage, and again in 1890 22,061*l.* for works of sewerage, and again 4,961*l.* for the same object in 1893, and 1,420*l.* in 1894. In 1899 there was a loan of 7,862*l.* for works of sewerage, and finally, in 1902, after a Local Government Board enquiry, sanction was given for a loan of 20,000*l.* for works of sewerage. Thus in sixteen years over 133,000*l.* has been borrowed for works of sewerage. Making the best estimate one can from the figures given, it is clear that the disposal of sewage cost the ratepayers about 17,000*l.* for the year ending March 31, 1899. Since then there has been more borrowing, and one can safely say that the ratepayers do not know the worst yet.

The maintenance of roads, streets, and paths amounts to 14,604*l.* for the year. The sewers have been laid beneath country roads with no houses, and the gravel paths replaced by concrete pavements, with granite curbs (imported, I believe, from Sweden) of maximum size. Very much of the expenditure has been wholly unnecessary. While the work has been in doing the roads have been more or less impassable. The placing of concrete over the roots of trees leads to their starvation, and after the unwelcome paviours had passed round my boundaries the privets in the well-kept hedge began to die, the wayfarers stared in, and all privacy was gone. Here was an instance of extravagant expenditure leading to a lessening of the amenities of life.

It will be noticed that over 9,000*l.* was spent upon 'private improvements,' most of this being under the Private Street Works Act, which was put in force by the Council in a most arbitrary manner. The Council has the right, under this Act, to make up and sewer private roads 'to their satisfaction,' to charge the householder whose property abuts on the road for the work done, with the addition of a percentage. In two instances which came particularly to my notice the action of the Council could only be called wanton. In one of these, that of a wealthy man whose grounds of twenty acres were surrounded by a footpath, the Council was only satisfied with granite curbs and asphalte, which cost nearly 2,000*l.*, which meant 50*l.* to the surveyor. This house stands empty, its owner preferring to move to a place where rates are lower and he is not used as a pigeon. It is possible that within a few years this beautiful spot may be destroyed, its ornamental trees be felled. Exit nature, enter jerry-builder.

In the other case a perfectly sufficient pavement was

removed from the front of nine cottages and the regulation concrete and Swedish granite put down, at a cost of 80*l.* to the owner.

What good has resulted from all this activity and extravagance on the part of the Council? They have provided sewers for the speculative builder; they have adopted by-laws which permit a back yard twenty-five feet deep as the maximum curtilage, and the result has been that the builders have been busy, and the country has been covered with rows of houses which are let as soon as built for eight or nine shillings a week, the landlord paying the rates.

Each house sends its quota of sewage to the sewage disposal works, and the result has been that the foulness of these works has steadily increased as the land has got sodden, until now the works constitute a very serious nuisance—a sewage marsh, which floods the air with sickening smells, and which serves as a breeding ground for myriads of flies. It seems probable that these sewage works, upon which the Council has spent, with the sanction of the Local Government Board, 133,000*l.*, will seriously depreciate the value of the district round them. My house was half a mile from the works, and when the wind blew from them it became impossible to sit in the garden.

I had been heavily taxed in order to pay for sewers, which I did not use, and in order that the rurality of the district might be destroyed by the jerry-builder, and I was finally driven out of it by stench. This is modern sanitation. The people who took the new houses with back yards as big as pigstyes were all Londoners; and being compound householders and not direct ratepayers, and being able to be quit of their houses by giving a week's or a month's notice, they could not be expected to take

much interest in municipal matters. It would be interesting to know what proportion of these new comers took the trouble to get upon the register. The bulk of the children were necessarily driven to play in the roads and streets, and the deadly dulness of the rows of monotonous slums was perhaps relieved by the troops of barrel-organs which came to add their quota of noise (often till 10 P.M.) to this rapidly growing rural Whitechapel.

The good houses, built by prosperous merchants and occupied by persons who had some local feeling and some attachment to 'home,' were shut up one after another, and many of them were taken to serve the needs of charitable and religious institutions. Many fell a prey to the jerry-builder, who made short work of the lilacs, thorns, and laburnums which used to make such a glorious show over the garden walls; and soon all was meanly monotonous, straight, rectangular, ugly, and 'to pattern,' and one was left to wonder why people were ready to incur the expense and fatigue of a journey to and fro in order to live in what was no better than a transplanted bit of city. Our recreation ground, for which the Council borrowed money in 1876, remained a dreary spot which certainly served for an occasional game of football or cricket, but which had no attractions for the speculative builder, who characteristically turned the *backs* of his mean houses to this modern 'village green,' which is made more dreary by the squalor of back yards, relieved occasionally by a little fluttering linen.

WHAT SHOULD BE DONE?

In the foregoing chapters the author has given abundant reasons to prove that the methods at present

adopted in our treatment of organic refuse are unscientific.

If our methods be bad in a scientific point, they must also be bad both morally and economically, and much has been said in support of both these latter positions.

It is easy to condemn, but it is not so easy to remedy. If a start be made on an unsound scientific basis, remedy is impossible, and I believe that for London, and the other big towns which have imitated her, there is no remedy. They must continue to blunder on as they have blundered in the past, and endeavour by huge expenditure and a merciless taxation of the householder to counteract the evils in connexion with polluted rivers, overcrowding, epidemics, and dwindling water-supply—evils which have increased, and will increase, because the hygienic arrangements of towns are more influenced by considerations of 'business' and immediate profit than by scientific considerations and a wise thoughtfulness for the future.

If the big towns merely serve as a warning to the country, and a standing example of 'How not to do it,' they will serve a very useful purpose.

Although *remedy* is hardly to be thought of for huge places which have got into a sanitary *impasse*, *prevention* is easy in places which still retain a fairly rural character.

The writer believes that an equitable adjustment of sanitary rates would prove sufficient to prevent the primary evil of unscientific sewage treatment and its secondary evil of overcrowding.

Our sanitary arrangements have a basis of pure socialism, or rather one would say of lopsided socialism, for not only are the rich taxed to provide sewers and water for the poor, but the sanitary saint is taxed for the

salvation of the sanitary sinner, to whom no punishment is ever meted out.

1. One of the reforms most urgently needed *is the supply of water by meter*. The possession of water under pressure is a priceless boon if it be not abused, and the only way to stop the abuse of water is to charge for it in proportion to the quantity used. If water were supplied by meter, and if water companies were made to adopt a sliding scale by which the rate of dividend and the price of water bear an inverse ratio to each other, many of our sanitary troubles would be at an end. All waste of water would cease, and with it the volume of sewage would decrease, and scientific methods of treating refuse would be adopted if it were found economical to adopt them.

It would, of course, be the house landlord's duty to provide an adequate supply of water to weekly property, and it would be the duty of the sanitary inspector to see that such property was kept clean. Poor men and women are constantly being fined for such a trivial offence as not sending their children to school, and one hopes that eventually some notice may be taken of sanitary sins which endanger the health of the neighbours. If this cannot be done, let us abolish our sanitary inspectors as being of no use.

The charging for water by rateable value is most inequitable, and now that the London County Council is claiming to fix arbitrarily the rateable value of our dwellings without reference to the sum paid for rent this iniquity is likely to increase. The writer's London house, with an average of four inhabitants, is charged more for water than was the case when the same house had nine inhabitants.

2. No cesspool or underground sewer should be per-

mitted to be constructed, even on private property, without license, because such underground collections of filth (whether in sewer or cesspool) have been shown to be capable of contaminating wells at a distance which is almost illimitable, and are a distinct danger to the community.

3. All water-closets which discharge into a public sewer should be taxed.

4. Those who make no contributions of foul water to a public foul-water sewer should not be called upon to pay for its construction or maintenance, provided that their sanitary arrangements are satisfactory and not likely to cause annoyance or danger to neighbours.

5. All sewers and sewage works should be constructed and maintained entirely out of rates levied on the ground landlords, because it is they, and they only, who make a profit out of that overcrowding of houses on space which is only rendered possible by sewage schemes, and which is too often the main reason for their inception. If the owner of a building estate choose to act independently and deal with the organic refuse of his estate, and if no foul water escape from his estate into a public stream, then, of course, he should not be called upon to pay for the construction of sewers, which are not only of no use, but a positive danger and annoyance to him.

6. The pollution of rivers ought not to be tolerated, and the Act for its prevention most certainly ought to be enforced against individuals.

7. It is, of course, imperative that all manufactories should be compelled to deal with their waste products, and should not under any circumstances be allowed to discharge factory waste of any kind into sewers or streams. Near the writer's suburban cottage are a

big brewery and a soapworks, both recently converted into 'Limited Companies,' and both paying good dividends. Why these two wealthy companies should not be compelled to keep their effluent out of the sewers and to filter it at home instead of having it done at the expense of the ratepayers is a mystery. The wealthy manufacturer who fouls rivers should be dealt with rigorously and mercilessly.

The question of manufacturing waste and sewage is a most important one. It is the manufacturers' sewage of unknown and very variable composition which puts great difficulties in the way of public authorities who are compelled to undertake the purification of town refuse. It is often poisonous, and generally, from an agricultural point of view, most dangerous, and effectually destroys the manurial value of sewage or sludge. The refuse and sewage of each trade are peculiar to themselves and need peculiar treatments, and no sanitary reform is more urgently needed than the compelling manufacturers to deal with their waste products and send a pure effluent to the rivers. What right have these wealthy manufacturers to be literally supported out of the rates, like paupers?

If manufacturers were compelled to deal with their own refuse and waste products, the factories would almost certainly be compelled to occupy more space than they do at present, and this rule, which seems equitable and reasonable, would have the effect not only of saving the ratepayer's pocket, but of checking that excessive overcrowding which is such a danger to the health of towns.

The populations of our big towns are kept alive by free trade, and the removal of duties on imported food has lessened the profits of the agricultural popula-

tion. Protection will never be tolerated again until the small agricultural holders outnumber the artisans, and that day is far distant. It may be said that the agricultural interests of the country have been largely sacrificed for the benefit of the manufacturer, and in exchange for this the agriculturist has a right to ask that the manufacturer shall neither be permitted to foul the stream from which his cattle have to drink, and which when pure is a source of profit to him in many ways, nor be allowed to destroy the manurial value of town sewage by causing strong chemicals to find their way into the sewers.

The country has made great sacrifices for the sake of the towns, and gets nothing in exchange but foul water and smoke.

The writer is not inclined to recommend any legislation, of which we have had far too much already, and which has caused precipitous action of a disastrous and ruinous kind in many parts of the country. What is wanted is more freedom of action, more encouragement for those who are striving to do well, and are a cause neither of annoyance nor expense to their neighbours, more rigorous treatment of the evildoer.

So far no attempt has been made to define the terms 'Rural' and 'Urban.'

In Rural places the production of food from the soil is the chief industry, whereas in Urban districts the cultivation of the soil is impossible, and the inhabitants, who congregate in one spot for purposes of trade or amusement, are entirely dependent on imported food.

The rural householder is responsible for his own water-supply, and therefore selects a site for his house where the ground-water is within reach of an ordinary

pump, *i.e.* where the well is not more than 25 feet deep. If a force pump is required to lift the water to the surface the labour of obtaining water, and therefore the cost of water-supply, is enormously increased, and the cost is in proportion to the depth of the well, or rather to the height to which the water has to be raised before being distributed to the consumer.

Any one who will be at the trouble to carry a pail of water (say, 3 gallons) from the basement to the attic of a 'three-storey' house may convince himself as to the labour involved, and he must not be surprised if he has to pay a considerable sum when this labour is provided for him.

When a countryman is deprived of his shallow well (often needlessly and in obedience to doctrinaires), and is compelled to use water under pressure (which he is encouraged to waste *ad lib.*), the increase in the cost of living is considerably enhanced.

When the excess of expensive water necessitates an expensive sewer, and that which should increase the fertility of his fields is merely washed into the river to poison his neighbour's water, and settle on the oyster-beds, the countryman is on the road which surely leads to rural bankruptcy.

It is evident that the 'sewer' must be popular with all who are connected with building, because it enhances the value of sites and relieves the builder of his greatest difficulties. The sewer is popular with labourers and artisans connected with the building trades, because it is likely to bring to them both work and wages, and for the same reason it is popular with the shopkeeper.

When, therefore, the question of sewerage is to the front it is tolerably certain of being carried, and those who vote for it do not trouble themselves about the

pollution of rivers and oyster-beds nor the load of debt which has to be paid by increased rates. Some see that their increased profits will more than counterbalance the increased rates, while the compound householder, who is never brought face to face with the rate-collector, knows nothing of rates and has not yet recognised that the sewer is one of the great causes of the increased rent which he has to pay.

It is clear to me that equity demands that all water-closets should be taxed as a first charge towards the payment of sewerage rates.

The legislature has thrown upon parish councils the onus of cleaning up the messes of the filthy and indolent, without giving the council power of applying any adequate compulsion to careless citizens.

A couple of houses which would not fetch two hundred pounds in the open market drain through a common pipe into a ditch, and the public authority is called upon to deal with it and to abate the nuisance *at the expense of the parish.* The rational thing to do would be to deal with this small quantity of sewage *in situ* by so-called bacteriological methods, *i.e.* a small tank, in which the sewage might settle, disintegrate, and clarify before being pumped over a filter or rubble or on to a bit of neighbouring land.

It would seem to be of the greatest importance not to unnecessarily increase the burdens of the agriculturist, whether farmer or gardener. If 'garden cities' are ever to be realised the cultivator of the soil must receive equitable treatment. This is not always the case. Many examples are to be found of boroughs parts of which are many miles from the town hall and are purely agricultural districts, very thinly populated. Nevertheless these outlying parts are taxed to provide water,

sewers, and pavement for the centre of the borough. This is inequitable and mischievous.

Sir Frederick Fitzwygram has kindly furnished me with the following laconic document, which puts the matter as tersely as possible and which I give in its original form :—

1. Origin of boundaries.

2. Existed before Norman Conquest.

3. Generally remained up to present day.

4. Up to late days no boundary could be altered, except by Act of Parliament.

5. Cost of Act, if not opposed, 1,000*l.*; if opposed, no man knows.

6. Of late years all sorts of schemes, water-works, land-drainage, gas, sewerage &c. started in all urban districts.

7. To save cost of Acts in each case, Parliament gave urban councils large powers for water-works, sewerage &c. by means of by-laws.

8. Urban boards were empowered to make special areas for such purposes, and also to impose special rates on areas so benefited.

9. But urban boards in some cases abused their powers, and rated the whole parish instead of the special area benefited.

10. These abuses existed for several years, until the Local Government Act, 1888, clause 57, gave the County Council power to transfer rural lands in the power of urban councils to rural district councils.

When the urban district of Havant proceeded to sewer the town and to send its sewage to settle on the edible molluscs in the creeks round Langston Harbour and Emsworth, a successful appeal was made to the Hampshire County Council to alter the boundary.

This successful appeal is a document which seems in every way worthy of reproduction.

APPEAL AGAINST POLLUTION

HAVANT SEWERAGE

We, the undersigned, Owners and Occupiers living in that part of the Parish of Havant which lies on the North side of the Stockheath and West Leigh Roads, which *cannot* in any possible way be benefited by the Scheme of Sewers proposed by the Urban Council,

Appeal to the County Council under section 57 Local Government Act, 1888, for a Separation Order for that portion of the Parish which lies on the North side of the Stockheath and West Leigh Roads, and is bounded on the East by Warblington Urban District, and on the West by Bedhampton, and on the North by Idsworth :

Your Memorialists object to the Scheme of Sewers proposed by the Havant Urban Council :

1st.—Because :

The Urban Council propose to sewer the Town *only* :

But they propose to place the sewer-rate *at once* on the whole parish :

Your Memorialists think this most grossly unfair;

Specially so in regard to the part of the Parish which lies on the Northern side of the Stockheath and West Leigh Roads.

2nd.—Because this district is wholly agricultural. There is only one Mansion, two Farm Houses, and a small Agricultural Village of Durrants of about seventy cottages. There is also a small Hamlet at Redhill, with one Mansion, a Parsonage, ten villas, and about fifty cottages on the North side of the ridge, which if drained, *must drain northwards* to Rowlands Castle.

3rd.—Because none of this district needs Agricultural Drainage.

4th.—Because this district is in no way connected with the Town Sewers.

The nearest point in this District is three-quarters of a

mile distant, whilst its furthest point is two and a half miles from the Town Sewers.

It may be urged that the Land Drainage Water, which comes down in considerable volume at times in winter, may necessitate a larger drain than would be necessary for sewer only.

There are two streams in the neighbourhood, which, without flooding, carry off all land water. The one on the East side (the Lavant) runs direct into the Harbour. This stream does not carry any Sewage until it enters the Urban District.

The other (the Hermitage) enters the 60-in. pipe laid down by the Water Works Company and discharges into the Harbour.

During the last fifty years Free Trade has greatly decreased the value of Agricultural produce, while, at the same time, it has largely increased the prosperity of our towns.

Your Memorialists think that it would be most unjust that Agricultural Lands and Buildings should be called upon to pay rates for the Drainage of the Town.

On these grounds your Memorialists ask that the above mentioned area may be taken out of the Urban and transferred to a neighbouring Rural Authority or constituted a separate Parish, under the name of North Havant.

CHAPTER XII

BURIAL

'All go unto one place; all are of the dust, and all turn to dust again.'—*Eccles.* iii. 20.

THE question of burial is but a part of the great question which we have been considering in this volume, viz. the power of the living earth to deal with organic refuse.

It is a mere truism to say that half the battle of life consists in dealing successfully with death. In England and Wales a human being dies about every minute, and domestic and other animals with a frequency that is still greater. In the vegetable kingdom the demands of death are equally inexorable. The proper disposal of dead and effete organic matter (animal and vegetable refuse) is a question which confronts every one of us at every turn, and I would submit that the disposal of the dead human body is only part, though a very important part, of the wider question. In this matter we have made a great advance, if we may assume that public opinion permits us to deal with the dead human body, the cast-off tenement of the soul, without superstition, and that all are agreed that the treatment, good or ill, wise or foolish, which the dead body receives at our hands can make no difference whatever to its late occupant. Far be it from me to say one word in disparagement of the sentiment

of loving respect which it is customary to manifest towards the dead. By all means let us honour to the utmost the memory of the mighty dead; but do not let us, as it were, worship the dead body of any man, however great, and seek to honour his memory by puerile attempts to hinder the natural and beneficent processes of dissolution. It seems a hopeless task to advocate scientific burial while it is still considered the greatest of honours to be buried, in defiance of science and common sense, beneath the pavement of Westminster Abbey.

There can be no doubt that earth burial may be spoken of as the 'natural' way of disposing of the dead. If a dead body were left where it falls (provided it fell in the open air under 'natural' conditions) it would soon be disposed of, and without offence, because it would be consumed by living animals, from big carnivora down to beetles and lower, and would soon be incorporated with the mother of all things, the earth, from whence it came, where it would nitrify, be dissolved, be absorbed by the roots of growing plants, reappear on earth in vegetable form, and thus complete the cycle of changes in which nature moves, a cycle in which life never ceases, a cycle which seems to be absolutely necessary for the smooth and harmonious working of the economy of nature. The only feeling which I have with regard to the question of the disposal of the dead body is that we are under a moral obligation to return it to the earth, from whence it came. As the living human body was supported by food which came entirely from the earth, so the dead human body, in common with all forms of dead organic matter, must be returned to the earth, there to undergo a physical transformation, and become incorporated with the structure of other living

things, both animal and vegetable. Our gratitude to the 'mother of all things' should make us very scrupulous not to deprive her of her due. If we wish a dead body to undergo a rapid and inoffensive dissolution we must bury it in the *earth*, and we must be careful not to bury it too deeply. The upper layers of the earth teem with life, both animal and vegetable, to such an extent that I have ventured to speak of them as the 'living earth,' and any dead organic matter placed in contact with this living humus is as much consumed as is the Parsee's body exposed to the vultures on the 'Towers of Silence.' If the body be placed tolerably near the surface, so that air may gain access, the process of dissolution is both rapid and inoffensive, and appears to be completed without any putrefaction in the ordinary sense.

In 1893 I practised a few exhumations of animals, in order that I might be able to lay some facts before the reader. In doing so I would remark that the process of dissolution, and the machinery which brings it about, offers a field to the naturalist which has not yet been adequately explored.

On June 24, 1893, a marmoset monkey, which had been buried in the previous November (about seven months), was exhumed. It had been buried in a box, which did not fit tightly, and at a depth of about eighteen inches. On opening the box sundry earwigs, woodlice, and small flies made their escape. The remains had no offensive smell. The flesh was almost gone, and what remained was permeated by fungoid growths—white, yellow, grey, and black. The flesh was easily separated from the bones, so that by merely placing the remains in a sieve and holding them under a tap of water we obtained the bones of the skeleton in a very clean condition. The bones of one forearm were missing. The

thorax contained an immense number of minute black globular bodies, probably the eggs of some insect.

On August 7, 1893, a cow which had been superficially buried in February 1892 was exhumed. The animal had been skinned before being buried, and the grave had only been made of sufficient depth to hold the carcass. The majority of the bones were found quite bare and polished. Here and there some tough, semi-solid material, permeated by fungi of various colours, was detectable. This was presumably altered flesh, but it was entirely devoid of any offensive odour. The soil round the carcass was full of animal life, the prevailing insect resembling a small white earwig. In this case the body of a full-grown (skinned) cow had completely disappeared in eighteen months. One of the ribs, which was removed, was perfectly clean and dry. The machinery of dissolution in this case was mainly small insects and fungi.

At the same time a horse, which had been buried in the spring of 1891, was exhumed. The animal had been buried in its skin, and at a greater depth than the cow, about half in the upper soil and half in the underlying chalk. The bones were almost entirely bare; but whereas in the case of the cow the bones were polished and lying loose and separate, owing to the complete disappearance of the tough fibrous ligaments, we found in this case the bones still covered with a certain amount of tough shreddy material of a dark colour, and the bones required a considerable wrench to separate them from their articulations. In this case there was no offensive odour, but dissolution was not so far advanced as in the case of the cow, notwithstanding that the animal had been a year longer under ground. The delay in the dissolution of this animal was perhaps

partly due to the fact that it had been buried in its skin, but it is probable that the greater depth of the grave was a more potent cause for the comparative tardiness of the process.

This theory was borne out by the third exhumation which we practised upon this occasion, viz. the carcass of a pony which had been buried five years previously, and in a grave of such a depth that the body was completely laid in the pure chalk some five feet below the surface. The spot of ground beneath which this pony was buried had been used for the collection of leaves for 'leaf-mould,' and had been habitually covered by a big mound of leaves. It was noticeable that dissolution in this pony was not so far advanced as in the horse, and that the carcass, when uncovered, was very distinctly offensive. It must be remembered that this pony had been buried twice as long as the horse, and nearly three times as long as the cow, and the comparative delay must be attributed to the non-access of air and of aerobic organisms, owing to the fact that the animal had been not only buried too deeply, but that the grave had been covered with a mound of leaves, which still further checked the access of air.

Lastly, on July 21, 1893, I buried a thrush in my garden with a garden trowel. On September 26, 1893, after sixty-seven days, I exhumed the remains, which consisted of a beautiful collection of clean bones, while what was apparently the thoracic cavity was filled with a 'comb' full of grubs which had been deposited.

The late Professor Flower stated that when he prepared the skeleton of a whale by burying it he found that in two years from the time of burial all the flesh had disappeared, and only the bones of the whale were left, and there can be no doubt that, if burial be scientifically

carried out, a very few years would suffice to humify the body, and the ground would be ready for the reception of a second.

I think there can be little doubt that if the body is to be quickly resolved into its ultimate elements, and become food for plants, it must be placed in the 'living earth,' and as near the surface as is practicable. In Mr. Athelstan Riley's account of the monks of Mount Athos we are told that the bodies of the brethren who die are interred for three years, at the end of which time the shallow graves are opened and the perfectly clean white bones are removed.

There can be no doubt that the more intimately the body and the earth are in contact the more rapid will be the process of dissolution, and that all coverings, and coffins, and vaults serve merely to hinder Nature in her work.

For the same reason we must not hinder the access of air to the pores of the earth, and therefore flat tombstones ought to be disallowed. The grave should have some simple mark for purposes of identification, but all monumental records should be relegated to a cloister. A body buried in the earth gradually undergoes a process of nitrification, whereby the animal tissues enter into the composition of mineral salts and become soluble and ready to be absorbed by the roots of plants. Therefore the final act of burial should be to plant the grave, in order that the earth may be purified by the action of the roots, and the air above be freshened by the oxygen given off from the green leaves.

The secret of success in burial, *i.e.* the rapid and harmless dissolution of the body, is simplicity. All expenditure merely hinders Nature in her work. A pit six feet by two feet, and three feet deep, is all that is

absolutely necessary, and if the body might be buried, so to say, where it falls, or in the nearest available piece of ground, the expense of funerals would be practically nil. If burials were conducted upon strictly scientific lines the same ground might be used for a succession of interments, a decent interval, say ten years, being allowed to elapse. If interments were conducted in this way, and if we may assume that an acre of ground would afford room for three thousand bodies, and if the process of burial in the same ground might be repeated every ten years, then it is evident that an acre of ground, to be used continuously, would afford accommodation for three hundred burials per annum. With a death-rate of twenty per thousand, three hundred deaths represent the annual death-rate of a population of fifteen thousand persons. It follows, therefore, that if we could induce people to accept strictly scientific burial, one acre of cemetery for every fifteen thousand inhabitants would be sufficient.

It is a *sine qua non* that ground used for burial must be made to produce, and that the planting of a tree or shrub over the deceased should be the final act of the burial rite. In Turkey, where shallow burial is in vogue, a cypress is invariably planted by the grave, but I am of opinion that trees of more lively aspect and quicker growth are preferable.

We often hear it stated that burial is an act fraught with danger to the living. Of this, however, there is very little evidence, and I am not aware of any serious outbreak of disease being definitely traced to a cemetery as a cause. This is remarkable: because interment is generally conducted in such a way as to hinder nature, and cause the production of offensive gases. Statements have been made, statements which I most readily believe,

that persons who have lived in the neighbourhood of masses of putrefying bodies have suffered in health; but, although burial has been much blamed in an indefinite way, there has been a singular want of well-founded specific charges. If, however, burial, as at present carried out, has not been productive of much mischief, that fact must be regarded as due to a happy accident rather than to our deserts, for burial, as at present conducted, is almost indefensible.

We hear it stated that microbes may carry diseases from graves downwards into wells, but I am not aware that such a statement has ever been proved; and on purely scientific grounds, seeing that the soil is the best filter for microbes that is known, such a statement does not commend itself as at all likely to be correct. Then, again, much has been made of Pasteur's statement that the spores of anthrax have been brought to the surface in the bodies of earth-worms; but this statement stands alone, and the source of the origin of the spores may have been on the surface, where the blood of the slaughtered animal had been left. In any case the statement only tends to show that it might be dangerous for animals to browse in a churchyard.

In the 'Journal of the Royal Agricultural Society' (vol. v. pt. ii.) will be found a paper by Professors McFadyean and Brown on the disappearance of the anthrax bacillus after death.

Professor McFadyean shows conclusively that in animals infected with anthrax the degeneration and disappearance of the bacilli begins at the moment of death, and in all cases is complete in three days if the carcass be not opened. This is due to two causes—(1) the stopping of the access of air by the cessation of respiration, air being essential for the growth of

the bacillus anthracis; (2) the growth of putrefactive organisms.

These writers are agreed that the best way of disposing of an anthrax-infected carcass is to bury it. For the development of anthrax bacilli access of air and a temperature of 70° F. are necessary. Neither of these conditions obtains in a body buried in the ground.

That germs of disease, escaping from the bodies of the yet living sick, have found their way into sewers and cesspools, and thence have trickled to wells and other sources of water, nobody doubts; but the mechanical condition of a body buried in the earth and a column of water leaking under pressure beneath the surface are so different that, even disregarding the probability that disease germs in a dead body fall a prey to saprophytes, it is hardly conceivable that microbes can pass through the earth, because experiment has shown that earth is the best of filters for such bodies. Were it otherwise it is hardly conceivable that any of us would be left to theorise about burial. We should all of us ere this have had practical experience of it.

When bodies are buried in deep vaults there is always a danger that the vault may leak and fill with water, and in that case we should have the mechanical conditions of a cesspool, so that if the vault continues to be filled with water it would be tolerably certain to leak persistently from its lower end. Setting aside all the extravagances of funerals, I think we may say that the practical experience of centuries and ages, equally with the facts of modern science, alike go to prove that burial in the earth is a perfectly safe process, provided the body be simply laid *in the earth.*

Simple burial in the earth is not only safe, but it is positively beneficial to the living, because burial grounds

form open spaces in and near cities, and tend to mitigate that fearful concentration of population which is the greatest sanitary evil of the present day, and concerning which it would be difficult to say whether it does more harm morally or physically.

If a cemetery be planted, and be made to produce green trees, shrubs, and herbage, not only is the earth beneath purified, but the air above is freshened. Further, be it remembered that the growth which takes place in a cemetery is a distinct gain to the living; for we are quite unable to prevent the fact that the burial of dead bodies increases the fertility of the soil. A cemetery properly managed must produce timber and firewood at least. The leaves which are blown away from it in autumn have a distinct manurial value wherever they may fall, and such nitrates as are not absorbed by the plants in the cemetery itself are dissolved by the percolating rain, which carries a measure of fertility wherever it may trickle.

Earth burial, properly conducted, is a distinct gain to the living, and in no sense a danger. Although I believe it impossible, if burial be properly conducted, that disease germs should be carried to our water-wells and springs, I am nevertheless conscious that some spore-bearing organisms are very persistent, and therefore I think we do wisely to regard a cemetery as a sacred spot, devoted *for ever* to the service of the dead. Under no circumstances whatever should burial-grounds be turned to other uses, such as building purposes or railway cuttings. It is shocking to my feelings as a sanitarian when I hear that churches and adjacent churchyards in the City have been sold for filthy lucre, in order that the people may reap the moral and physical harm which comes of overcrowding, and one is

not without hope that the Church may some day pronounce against such practices.

The belief, so common in the present day, that every bit of ground that does not carry a factory or a pile of offices is wasted, is a belief which is very full of danger to the public health. We ought to be very chary how we abandon any practices which serve to mitigate the over-concentration of population; and the time-honoured practice of earth burial, if rationally conducted, is one of those which automatically provide open spaces which separate the living and freshen the air with vegetation.

Some are saying that land is no longer obtainable for burial purposes, but to this argument I have only to reply that land was sold in 1893 for 37*s*. 6*d*. per acre, and that the country is simply scored with railways, which are quite as ready to carry the dead as the living.

The gist of my remarks has thus been, that earth burial is not only safe, but that its safety lies in absolute simplicity. All expenditure on funerals is not only wasteful, but positively harmful. If a body be simply laid in the earth, and the grave be planted, burial becomes an act which is not only beneficial but absolutely profitable to the living.

In order to carry out this extreme simplicity in funerals it will be necessary to diminish the ceremony at the grave to the utmost, and to provide coffins which shall be used merely for the transport of the body, but which should, as a final act, be withdrawn. Such coffins should be made of metal, so that they may be disinfected or polished, and they might be made as beautiful as possible.

In a paper communicated to Section IX. of the Seventh International Congress of Hygiene and Demo-

graphy (London, 1891), entitled 'L'Assainissement des Cimetières,' MM. Brouardel, du Mesnil, and Ogier state—

1. '. . que l'atmosphère des cimetières actuels est pure de tout produit gazeux délétère, de tous les éléments figurés nocifs. .

2. 'Que dans les cimetières actuels le sol ne renferme que de l'acide carbonique en grande quantité à l'exclusion de tout autre gaz en quantités appréciables.

3. 'Que la décomposition des cadavres confiés à la terre serait vraisemblablement activée par le drainage du sol.'

And in a second report they further state—

1. 'Que plus le cadavre est en contact avec l'air par le fait de la perméabilité du sol, de la porosité de la bière, plus sa destruction est rapide et complète ; la présence de l'air favorisant l'éclosion de ces êtres inférieurs, *de ces travailleurs de la mort* qui sont les agents les plus actifs de la destruction des cadavres.

2. 'Que toute substance mise dans la bière pour en assurer l'étanchéité—sciure de bois mélangée ou non de substances antiseptiques ou simplement aromatiques, poussière de charbon, feuilles de caoutchouc, de carton bitumé doublant la bière—retardent dans une proportion considérable la destruction des cadavres.

'Toutes ces matières s'opposent au développement des animalcules la plupart aérobies qui paraissent être les agents les plus actifs de la destruction des cadavres.

3. 'Que l'inhumation dans un sol humide ou imperméable retarde considérablement la putréfaction.'

This extract seems to show that in burial, as in other things, we have only to follow nature in order to attain our end, and that the unwholesomeness of the well-managed cemetery is illusory.

CREMATION

There are some who advocate cremation in place of burial in the earth, but I hold that cremation is not necessary; that it is almost hopeless *to expect a general* assent to the practice; that it is wasteful; *and that it* would often defeat the ends of justice. Burial in the earth, if decently and properly conducted, is a safe and healthy practice.

The advocates of cremation use as their stock argument the danger to the health of the living that is caused by the burial of the dead. The germs of zymotic disease, they urge, are thus kept alive and find their way to the wells and watercourses.

Granted that in the dead body, as in the excremental and other matters escaping from the sick, there may be living particles capable of carrying infection, we should expect to find that those most associated with the dead and with excremental matters would give some indication of this danger if it be practically important.

As a matter of fact, the three healthiest classes are (1) the clergy, who habitually live by the side of a graveyard and get their water from a local well; (2) market-gardeners, who are constantly dealing with enormous quantities of manure, a large part of which must be theoretically capable of conveying infection; and (3) farm labourers, who run the risks of market-gardeners, but in a less degree.

In considering the question of Burial *v.* Cremation we must be careful to separate essentials from non-essentials. The pomps and vanities which have grown up round the simple act of interment have become intolerable, and there can be no doubt that the certain amount of popularity which cremation enjoys is due to the fact that it affords a ready means of escape from these oppressive conventionalities.

There can be no doubt that, if we wish to maintain the fertility of a country, all dead organic matter which emanates from the soil must be returned to it.

There are at present enormous tracts of fair agricultural land which can be bought for 20*l.* or even 10*l.* per acre, so that it is idle to talk as if the procuring of land for cemeteries were a serious difficulty.

The cremation of a body involves a needless dissipation of energy. Not only has the fuel used for cremation to be paid for, but the air is fouled with the products of combustion, and the inevitable destiny of those products (*i.e.* to become food for plants) hindered to an extent which we cannot estimate.

To regard the dead body as a fertiliser may shock the sensibilities of some, but looked at philosophically this point of view is inevitable, for, even when cremation is practised, the products of combustion must ultimately become the food of plants, somewhere and somehow. Why not go with nature instead of against her? Why not employ the economic process of inhumation instead of the extravagant and thriftless process of cremation?

There is only one way of keeping the soil pure and wholesome, and that is to make it bring forth. In time of war or famine there could be no objection on sanitary grounds to growing any ordinary crop in a cemetery, but we shall all agree that the most suitable crops would be flowers and flowering shrubs, and it should be an object to make our cemeteries as beautiful as possible.

One is at a loss to understand what is meant when advocates of cremation talk of inhumation as a topic too ghastly to be mentioned. There is no offence whatever, and from the æsthetic point of view the advantages are altogether on the side of scientific burial.

The products of cemeteries must have a definite value

and would provide a large amount of firewood, and this secondary cremation, by which the dead provide warmth for the living, is a cremation to which nobody can object.

At present we are busy in burning all the combustible refuse of our towns, and by gross mismanagement our excremental matters have become a danger instead of a blessing to the soil. Agricultural depression is, one can have no doubt, in part at least attributable to this cause, and now comes the proposal to cremate the dead, which will foul the air and starve the soil still more.

If the interment of the dead be conducted upon scientific lines, and if the cemeteries be made to produce trees and shrubs, the soil may be used for interment (after an interval) over and over again, and there can be no doubt that its ability to nitrify and humify the body would progressively increase with each repetition of the act.

The process of cremation involves, as I have said, a dissipation of energy, and the same remark is equally applicable when any organic matter which is capable of nitrifying and humifying is destroyed by fire. Fire brings destruction, but organic refuse, when buried in the earth, is started upon a round of creation which (we cannot help it) freshens the air, feeds the hungry, clothes the naked, warms the shivering poor, and finds labour for 'the unemployed.' In cities we are so closely packed that it is no longer feasible to put organic matter to its proper use. Your true cockney browses on imported corn and tinned food, and is necessarily ignorant that organic refuse has any legitimate destiny except to foul the Thames or feed somebody's patent 'destructor.' He cries to be relieved of his organic refuse, which is to him merely a nuisance to be got rid of. He has entered upon a policy of destruction which is unscientific and thrift-

less, and the proposal to cremate the dead is merely a part of a policy which will eventually do for England what a similar policy in ancient Rome did for the Roman Campagna.

To sum up the merits of cremation and inhumation we must admit that, with regard to ceremonies to be observed, there need be no difference, and that in both it is equally necessary to provide for the transport of the body and a suitable preparation of it, sufficient to allow of its being decently placed in a hole, and whether this hole take the form of a furnace or a grave makes no difference.

There can be no doubt that burial is the shorter process, for to dig a hole having a capacity of 36 cubic feet, to lay a body in it, and cover it up again, would not take many minutes.

Next, let us look at the financial aspects of the question.

If we allow for each adult interment the space of 6 feet by 2 feet, then 3,630 adult bodies could be placed in an acre of ground, and there can be no doubt that, if it were necessary, it would be possible by a little management to utilise every square inch of an allotted space without superimposing one body on another.

It is stated in Chambers's 'Encyclopædia' that the cremation of a body at Woking occupies about an hour and a half, and takes about seven shillings' worth of fuel. It is evident that the cost *for fuel only* of cremating the number of adults capable of being buried in an acre of ground would be 1,210 guineas (1,270*l*. 10*s*.), and this represents the price which might be paid for land for burial purposes before cremation could in comparison with earth burial be considered economical.

Any land which is in a condition to produce ordinary

for farm crops may be regarded as suitable for burial, provided it be properly drained, &c.

The writer calls to mind a small parcel of land within five minutes' drive of an important railway junction between sixty and seventy miles from London, which recently cost 33*l.* per acre. If this ground were filled with one layer of adult bodies, each body having $6 \times 2 = 12$ square feet, then each body would occupy almost exactly two-pennyworth of ground. There are hundreds and thousands of acres of such land to be had for similar or lower prices, and it is not necessary to cry out about the difficulty of obtaining land for burial purposes. It is obvious that ground used for burial must become exceedingly fertile, and should be correspondingly wholesome, profitable, and beautiful.

From the financial point of view there can be no doubt that burial is cheaper than cremation. The burning of a body plus seven shillings' worth of fuel must foul the air. Granting that smoke and offensive odours are both done away with by using proper furnaces, the ultimate products of combustion must render an enormous volume of air noxious and irrespirable. The atmosphere of this country is sufficiently fouled as it is without needlessly adding to its impurity.

The ground in which a body is scientifically buried would be soon covered with herbage and green leaves, which serve to freshen the air instead of fouling it.

If our cemeteries are to be replaced by furnaces with tall chimneys pouring their products of combustion into the air, it is self-evident that the cities will gain nothing by the reintroduction of a mode of disposal of the dead which, whatever may be its merits, is not in accordance with the teachings of modern science.

To sum up: it appears that, as compared with

cremation, inhumation is cheaper, simpler, and quicker. It is *productive* and not *destructive*, it is indirectly a cause of freshening the air instead of fouling it, and provides a lovely spot for the enjoyment of the living.

At the Church Congress at Birmingham in 1893 a distinguished sanitary engineer advocated cremation as against inhumation, notwithstanding that at the time he was speaking coals were (in consequence of a strike) fetching two pounds a ton, while land a few weeks previously had exchanged hands in Essex at 37*s.* 6*d.* per acre. This, one fears, is typical of the thriftless extravagance of engineers in sanitary matters. An engineer who adopts the motto that 'forks were made before fingers,' and whose ingenuity is stimulated by the help of a public purse, is a luxury which is apt to prove irksome in the end.

CHAPTER XIII

THE STORY OF BRÉMONTIER, AND THE RECLAMATION OF THE SAND-WASTES OF GASCONY[1]

In the short address which I have the honour to give to you this evening, I purpose to bring to your notice the chief facts of a great sanitary work which has been accomplished by our friends and neighbours, the French.

If you will take the map of France and look at that portion of the coast which skirts the Bay of Biscay, you will notice that two great rivers flow into the sea along this coast. One, the more northerly, is the Gironde, a stream which has upon its banks the great commercial city of Bordeaux; the other river is the Adour, the mouth of which is 150 miles south of the mouth of the Gironde.

Between the mouths of these two rivers the shore of the Bay of Biscay is formed absolutely and entirely of sand, and for a considerable distance inland from the coast the soil of France is composed of sand. It is to this great sandy district, covering nearly two millions and a half of acres, and known in France as the 'Landes,' or Moorlands, that I wish to direct your attention.

These moorlands have been the despair of agriculturists for centuries, and have been universally regarded

[1] This chapter formed the subject of an address to the working classes delivered at York in 1886 on the occasion of the Congress held by the Sanitary Institute. Its original form has not been altered.

as among the dreariest and most unwholesome districts in Europe. Sand has not the reputation of being a very profitable soil to the agriculturist, and in addition to the natural poverty of the soil the farmer in this region has had to contend with the impossibility of efficient drainage. The Landes formerly produced nothing except a scant herbage sufficient to support a few miserable sheep, tended by shepherds as ill-favoured as their flocks, who generally suffered from one or other of the many diseases prevalent in the country; for disease was about the only crop which the Landes formerly brought forth abundantly.

Indeed, you will find that plains which are unproductive are generally unhealthy. The Campagna round Rome is a very hotbed of malarious and other diseases, and the sandy plains of Holland, and our own Lincolnshire, enjoyed a similar evil repute, before efficient drainage was brought about by skilful engineers, and the cultivation of the soil became possible. Husbandry and disease are sworn foes, and the pursuit of agriculture is generally the pursuit of health, and a healthy man is generally contented. Here is an argument for 'small holdings,' for 'three acres and a cow,' and for 'allotments,' which I freely give to those who find pleasure in political contention.

The drainage of the Landes presented special difficulties, and difficulties which no engineering skill and no expenditure of money in the direction of bricks, mortar, and machinery seemed likely to overcome, and for the following reasons:—

The reputation of the Bay of Biscay is familiar to every Englishman. It is there, if anywhere, that the force of wind asserts itself, and the winds are generally westerly in direction, and blow with fearful violence from

the sea over the land. The shore of that part of the bay with which I am dealing is composed, as I have said, of unmitigated sand. The effect of the wind upon sand is familiar to all of us, for the sand is borne before the wind and travels considerable distances.

Now, in the Bay of Biscay the rise and fall of the tide is great, so that the sand washed up by the sea is left high and dry to the extent of many feet at low water.

Again, in the latitude of the Bay of Biscay the sun is far more powerful than here, so that in the interval between the times of high water the sand is greatly heated by the sun, and is so thoroughly dried that the particles no longer tend to stick together—glued by natural moisture—but are easily driven before the furious blast which comes roaring from the sea. When the wind is not very strong it blows the sand into heaps along the shore. These heaps or hills may reach an elevation of from 60 to 300 feet, with an inclination of about 30 degrees towards the sea. These heaps of sand are called 'dunes,' a word having the same origin probably as the English 'down,' and formerly the whole foreshore of the Bay of Biscay, between the Gironde and the Adour, presented an undulating appearance, as though a portion of the swelling, rolling sea had been turned to sand and become stationary. If these sandhills had been really stationary they would have formed a natural rampart against wind and waves, and it might have been possible to drain and cultivate the land behind them. But this was not the case. The scanty herbage of grass and reed which grew upon the dunes was not enough to fix them. It only required a gale of moderate force to completely alter the face of the country; hills became flat, valleys were filled up, the

lakes which formed behind the dunes became dry land, the water which the lakes contained was forced in some new direction, and what happened to the lakes also happened to the watercourses, with the result that the whole country was waterlogged, and fields and gardens which had been painfully and industriously cultivated were submerged by the drifting sand. It is even stated that villages disappeared completely in this way, and that an enterprising agriculturist in digging his estate was surprised at finding just beneath the surface the brazen weathercock on the steeple of a long-forgotten parish church! It is a great labour, even at the present day, to keep the mouths of the Gironde and the Adour free from drifting sand, and it is certain that a century or so ago the course of the Adour was completely changed, owing to the channel getting dammed by sand blown into it. If an accident such as this could happen to a mighty stream like the Adour, one may judge of the great uncertainty which attended the course of smaller streams, and the absolute impossibility of draining the land.

A few feet below the average level of the surface of the district there is an impermeable stratum, locally known as *alois*, which keeps the water from flowing away, and beneath the impermeable stratum was more sand sodden with undrinkable water.

The result of this condition of things naturally was that the district of the Landes during the wet season was a swamp, and during the dry season a pestilential morass. The district was uncultivated, and produced nothing but scanty herbage, which served as pasture for a few wretched sheep, tended by shepherds doomed to spend their lives upon stilts, for the country was such that it was impossible to walk far in any one

direction without sinking to the waist or shoulders. The country produced no corn, and the population was the scantiest in proportion to acreage of any district in France. The population was kept down also by disease. Fevers of all kinds—and especially those of a malarious type—were exceedingly common. In addition, there was a disease peculiar to this and a few other districts in Europe, known as Pellagra, a terrible disease, which disfigured and slowly killed; the patient dying with the aspect of a mummy and the mind of an imbecile.

The Landes had remained for centuries as a blemish on the fair face of France, and all attempts to reclaim and cultivate them had signally failed. The Emperor Charlemagne, it is said, employed his troops in the intervals of his Spanish campaigns in an attempt to reclaim the Landes, but the forces of nature laughed at the puny opposition of the greatest magnate of the world, and at once resumed their sway as soon as the imperial soldiers had ceased to dig ditch and throw up bank.

I have no fear of being contradicted when I say that it is of no use to attempt to fight with Nature. We may oppose her for a time, but only for a time. In the end she asserts her sway, and man sees too late how his labour has been in vain.

Dwellers in these islands do not need to be reminded of the awful and irresistible power of wind and wave, against which the mere dead weight of Cyclopean breakwaters, constructed at gigantic cost and maintained by constant periodic expenditure, is at times laughably impotent. I need not say that the wind and waves of the Bay of Biscay are the roughest and rudest in the world, and that if the maintenance of dead breakwaters

is an endless and almost hopeless task on our coasts, on the stretch of coast which I am considering their construction and maintenance would be alike impossible. Thus it was that until the latter end of the last century the condition of the Landes, a tract of two millions and a half of acres, seemed hopeless, and they seemed doomed to be open to the fury of sand storms for ever and to remain a pestilential, unprofitable, undrained swamp to all eternity.

But, happily for France, and especially for the dwellers between the Gironde and the Adour, there was born in 1738 Nicolas Thomas Brémontier. It is said that the world knows nothing of its greatest men. Certain it is that Brémontier was one of the greatest benefactors to humanity that the world has ever known, but I regret to say that I can tell you very little about his life. This would have been less but for the kindness of Mr. Jenkins, the late Secretary of the Royal Agricultural Society, who obtained from Paris the following extract from the memoirs of the Agricultural Society of the Seine. This short biographical notice of Brémontier is from the thirteenth volume of the 'Transactions' of the Society (for the year 1810), and was most courteously extracted by M. Laverrière, the librarian:—

'Nicolas Thomas Brémontier was born at Quavilly, near Rouen, July 30, 1738, and soon manifested great aptitude for the exact sciences. He was very young when he entered the school of the Ponts et Chaussées, and at eighteen he went to the College of the Marine Artillery at Toulon, to teach applied mathematics. This school, established by M. Choiseul, was broken up a few years later, and Brémontier went, as Engineer of Roads and Bridges, first to Périgueux, and then to Bordeaux. Here he was actively engaged in his profession, and

published papers on the drainage of marshes in the neighbourhood of Bordeaux, on the cleansing of the Bordeaux harbour, and on the methods of restraining rivers and torrents to their proper beds. His energy was inexhaustible, and in his leisure he taught himself the principles of music, and became in this direction most efficient. Promoted to be Inspector of Roads and Bridges, he went to Brittany to make a canal to join the Rance to the Vilaine. Thence he was sent to Normandy to make a canal from the Orne, by Caen, to the sea. At Caen he reconciled the differences which had arisen between the provincial magnates and the officers of the Ponts et Chaussées, and his judgment and conciliatory spirit had proved useful in a similar way in Bordeaux. When, therefore, the post of Engineer in Chief for Guienne became vacant, he was appointed, in obedience to the wishes of the locality.

'Brémontier joyfully accepted this post, not merely because it was at once a professional and social promotion, but mainly because while formerly living at Bordeaux he had been a witness of great troubles for which he believed he had found a remedy; at least his early experiments (conducted at his own cost) gave him a strong cause for hope. Brémontier felt that here was to be the theatre of his greatest and most useful labours. Possibly, we might believe, he thought to earn an imperishable fame; for self-interest, we are prone to think, is the main spring of good works. Brémontier had less need of such a spur than most men.

'He had visited the sandhills of Gascony during his first sojourn at Bordeaux, and bewailed the misery caused by those moving mountains thrown up by the sea and driven by the west wind, which had already smothered a vast tract of cultivated land, as well as rural inhabitants

and villagers, and which threatened to cover the more fertile districts and advance even to Bordeaux itself.

'The idea of arresting this devastating power took possession of Brémontier, and the hope of success occupied entirely his brain and hands. He studied the nature and the movements of the sand, he measured their extent, and noted the ravages past and to come.

'He recognised its vegetative power, and from the year 1787 he knew that a great number of plants, and especially resinous trees, could find nourishment in them. He made experiments at his own cost to get some definite facts. He perfected his method of procedure, and at last, certain of success, and feeling that such an enterprise was beyond the power of a single man, he sought the help and succour of the Government. His assertions were not credited, and his project shared the fate of many other creations of genius which are repelled at their birth by the ignorant, until the results become so numerous and evident as no longer to be neglected.

'After Brémontier's first attempt the solid basis of procedure was found, and the extension of his work alone was necessary. What proportion was there between the few acres planted at the cost and by the care of one man, and that vast stretch of country extending from the Gironde to the Adour, nearly 180 miles, and averaging three or four in breadth, all exposed to the action of the destructive sand and in part covered by it?

'During his second residence at Bordeaux he renewed his application to the Government, this time still more certain of the success of his project.

'In a short notice like this it is not possible to enter

into all his trials and difficulties, nor to dilate upon the dangers to which he and his works were alike exposed during the period of anarchy to which France at that time was so long a prey.

'The genius who then controlled the destinies of the Empire appreciated the value of Brémontier's projects, and in the year 1801 he allotted 50,000 francs for the continuance of the work, and a similar sum has been allotted to it in each succeeding year.

'Brémontier now began to enjoy the fruits of his labour, and in 1808, 3,700 hectares of land (about 9,000 acres) had already been sown. Honoured by the esteem of the department of Ponts et Chaussées, he had been promoted to the rank of Inspector-General, and he was chosen by his fellow-citizens of Bordeaux to be one of a deputation to wait upon the Emperor at Bayonne. He had then the happiness to submit to this great ruler his future projects and his past success, and felt certain that from that time the great work to which he had devoted himself would not be abandoned, and that its future success was assured. The fixation of the whole of the Dunes is now ranked among the great public benefits to which Napoleon, with the instinct of a genius, gave his support. Brémontier in his dying hours was doubtless consoled by this pleasing prospect, and he breathed his last surrounded by his friends, with the calmness and resignation of a true philosopher.'

Brémontier recognised the fact that the only way to grapple with the forces of nature is, not to fight blindly against them, but to try to make use of them. Nature is always working for our benefit, and although at times, in a fit of anger as it were (the real object of which we may fail to comprehend), she destroys much of

her own work, still, in the long run, those who endeavour to turn her forces to account will find the balance enormously in their favour.

It is well known, and has been long recognised, that the best protection for a bank or rampart against the fury of the elements is to plant it. A loose heap of earth is liable (no matter how huge it may be) to be washed and blown away in times of tempest. If, however, the bank be planted, the roots of the trees and plants hold the elements of the soil together, and the spreading branches and leaves form at the same time a protection from the fury of wind and water. It is true that even planted hills and banks may suffer severely in times of exceptional storm, but the storm once past, the silent forces of nature commence at once the work of reconstruction; the damaged roots send forth fresh rootlets, the damaged branches soon push again with buds of promise, and possibly before the advent of the next exceptional gale the storm rampart is stronger than before. These silent forces of nature are truly beneficent; they merely ask for fair play, they work for us without wage; and one great principle of success in all work in this world, be it legislative, be it sanitary, or be it of any other kind, is to go with them, not to fight against them, to learn if we can what is nature's inexorable law, and lay to our hearts the fact that nature brooks neither stubbornness nor disobedience.

Brémontier recognised the fact that the only way to fix the drifting sand-dunes was to plant them: but how, and with what? These were the questions he had to solve. Sand is not regarded as a promising soil by agriculturists in general, and the sea-sand along the shore is the least promising of all. And yet sand must contain in its interstices a good deal of organic matter

left by the seaward-tending rivers, and the fact that the sandy estuaries of rivers are very liable to serve as breeding grounds for mosquitoes which propagate malaria may be taken as evidence that organic matter must exist in quantity and in fine division among the minute particles of sand. In the spring of 1886 I was astonished at finding, close to Biarritz and within a few yards of the sea, a flourishing crop of peas which had been sown in the sand without, apparently, the admixture of any manurial body. They were protected from the sea-winds by hurdling made of gorse, and enjoyed an ample exposure to the sun, and thus bid fair to yield a good return in due time. The pea is a plant that sends its roots very deeply, and the roots doubtless found moisture and nourishment at a great depth below the surface. For fixing dunes, however, something more permanent than peas is necessary, and Brémontier resolved to try the *Pinus maritima*, a tree which was known to flourish in sandy soils near the coast. The *Pinus maritima* is a species of Pinaster, and in habit and size it very much resembles the common 'Scotch Fir,' with which we are all familiar. Brémontier made his first sowings of the seeds of the *Pinus maritima* in the year 1789, and I will state shortly his perfected manner of precedure by which he overcame the obvious difficulties of his task.

I wonder what the dull-minded and prejudiced peasant thought of this enthusiast who went forth to do battle with the mighty ocean, and still mightier wind, armed only with a few handfuls of pine seeds, such as might be driven far away by the first strong gust that blew. I wonder also if only the ignorant laughed at him, and if he escaped the jeers and sneers of those who had enjoyed the advantages of a better education. Probably not, and equally probably he cared little for the

opinions of the prejudiced. The pine seeds were sown mixed with seeds of the common broom, and the sowings were made in a direction at right angles to the prevailing wind. A screen of hurdles made of gorse or of planks deeply driven into the sand was placed on the windward side of the seed-ground, and the seed-ground itself was thatched with pine branches and other suitable material. At the end of the first year the broom would be nine or ten inches high and the pine saplings only two or three inches, and thus the tender little saplings were nursed and protected by the plants of broom. In half a dozen years or so the brooms had reached their full growth, but the pines continued to grow, and, in course of time, overtopped the brooms, and smothered their nurses. Being judiciously thinned and pruned by the foresters, the pines grew into fine trees able to resist the fury of the elements, sending their long tap-roots and laterals in all directions through the dunes, and causing them to become year by year a stronger and stronger protection to the inland wastes instead of a dangerous menace. At the dawn of the nineteenth century Brémontier had proved the success of his practice. In the year 1801 the matter was taken in hand by the French Government, and in 1810 it was ordained that so much of the sand-dunes as belonged to the State should be planted after the manner of Brémontier, while the private property of those who were unwilling or unable to plant should be taken in hand by the State, all revenue arising from such land being confiscated until the cost entailed by the work had been recouped.

In 1817 a yearly sum of less than 4,000*l*. was voted for the reclamation of the dunes and wastes of Gascony, with the result that, in the department of the Landes, 98,000 acres of forest have been planted; and whereas

in 1834 there were about 900,000 acres of uncultivable land in the department of the Landes alone, there are now only 340,000 acres, showing that in the past half-century reclamation has proceeded at the rate of 12,000 acres a year. These figures apply only to the department of the Landes, and leave out of consideration the department of the Gironde, in which, however, nearly half these waste moorlands are situated. This reclamation has been made possible by the fixation of the dunes, which has rendered systematic drainage operations practicable. Canals and drains have been cut in every direction, and, thanks to the pine forests, there is now no longer any risk of their being choked up with sand.

The *Pinus maritima* has proved a very profitable tree. Within twenty or twenty-five years of sowing it begins to yield a return. The timber is of very moderate quality, but is largely used for packing-cases, for shores in the dockyards of Bordeaux, for railway sleepers, and for firewood. I may remark in passing that the great scarcity of coal in France compels the French to look to their forests for fuel, and there is probably no nation more clever and more thrifty in the management of trees.

The pine trees are chiefly valuable for their yield of turpentine and resin, which in that comparatively warm climate is very abundant. The resin is obtained by removing a strip of bark from the tree and allowing the exuding sap to trickle into a small earthen vessel shaped like a flower-pot. The trees begin to yield resin when they are about twenty years old, and the resin is worth about 5*l.* a hogshead in its crude condition. As far as I am able to judge, it requires about 250 trees on an acre of ground to give a hogshead of resin. It requires comparatively little labour to collect the resin, so that the profit per acre from the resin harvest is considerable.

It is said that the draining away of the resin does not seriously affect the value of the timber. Besides resin and timber the manufacture of charcoal is largely carried on—charcoal, as you are aware, being in great demand in France for a variety of purposes.

Thus it appears that the waste moorlands on the shores of the Bay of Biscay have become of great commercial value. Journeying from Bordeaux to Bayonne, the railway passes through one long monotonous pine forest. When I state that the journey takes between four and five hours, you will be able to judge of the vast tract of country which, once the abomination of desolation, is now covered with millions of the resin-yielding *Pinus maritima*. The cultivation of the pine improves the soil, which is gradually enriched and altered in quality by the dead leaves and other vegetable débris which fall upon it. In some places clearings have been made in the forest and vineyards planted, and I need not remind you that the most valuable vineyards in the world are on the southern bank of the Gironde, on the very fringe of the pine woods which I have been describing.

The rise in agricultural value of this tract of country, great as it is, is a smaller matter. The great gain after all has been the rendering wholesome of a pestilential swamp and the removal of a plague spot from the face of nature. The shepherds of the Landes, except in very few places, have now no longer any need to walk about on stilts, and malaria and pellagra from being common have become rarities, and will soon be extinct. Life in this district no longer languishes and ends prematurely, but the inhabitants enjoy vigorous health, and that happiness and contentment which vigorous health alone can give.

Population has increased very rapidly since the beginning of the century, and industries of various kinds are able to be carried on. Round the basin of Arcachon is a very large population, supported mainly by the oyster fisheries, and the town of Arcachon, which has grown up in the pine forest, is one of the well-known health resorts in Europe, where land in the best situations is worth about 1,000*l.* an acre. Well may the dwellers in Arcachon raise a statue to Brémontier, whose far-seeing and thrifty policy has brought them health, happiness, and riches in place of disease, misery, and poverty.

I have now given you the simple details of the manner in which Brémontier's small beginning has made great end; how his pine plantations, made at first with no little labour and sorrow, began along the coast, and with the lapse of a century have reclaimed a province.

You will be asking, perhaps, why I have chosen this subject for my short address to the inhabitants of York, and having listened to my tale, you will be asking for the moral.

I chose this subject for my address for several reasons. The chief reason probably is to be found in the fact that I spent part of the early spring of this year in the district which I have been describing, and what I saw there made, as it could not fail to do, a very deep impression upon me.

My next reason was that it is an aspect of sanitation which is not often dealt with at meetings like this, and I was glad of the opportunity of taking you away from pipes, traps, sinks, and those expensive roads to health which we have to consider in cities, to contemplate the sanitary effect of good husbandry in the open air; and

to show you on a large scale what I believe to be universally true, viz. that the cultivator of the soil must always be the right-hand man of the sanitarian.

It has been refreshing for us to contemplate a sanitary work which has proved a financial success. Sanitation always gives us the best of all dividends—health. It is said to be a short-sighted policy, especially in cities, to look for a money return on the capital expended on works for improving the public health. The thrifty French, however, have given to the world a valuable example of a comparatively small expenditure yielding *in the course of time* a magnificent return of both health and material prosperity.

Do not run away with the idea that the *Pinus maritima* is a cure for all waste lands and unwholesome districts, because it happens to be especially suited to the soil and climate of the eastern shores of the Bay of Biscay. In the warm climate of the south it yields abundance of resin and turpentine, grows quickly, and furnishes a large quantity of timber. In more northern climates it will grow, but does not flourish; and although there is at least one fine specimen in Kew Gardens, it is not, from all I have heard, a tree suited to this climate.

My story seems to show that in the reclamation of waste lands we must not be in a hurry. Nature is sure, but from our point of view slow. Brémontier, and those who worked with him, began in a small way. We may be sure that experience had to be bought at more or less expense; and it was not until the success of his methods had been proved that the French Government seriously took the matter in hand. Brémontier was a true patriot. He worked solely for the good of his country and for posterity. He had no idea of immediate profit, either for himself or his contemporaries. He drew his modest

salary as Inspector-General of Roads and Bridges, but looked to no further profit. He lived barely long enough to see the resin flow from his first plantings. He pointed out, as it were, the way to the promised land, but for himself he only saw the promised land 'in his mind's eye.' It is good for us to bear this fact in mind, for many reformers of the present day seem, in questions of land management, to look only for immediate results, and to be actuated by the not very noble sentiment of 'Bother posterity! What has posterity done for me?'

There has been a good deal of talk of late about the reclamation of waste lands in this country, and the opinion of some seems to be that worthless soil presents a glorious opportunity of wasting money. These are questions concerning which I cannot speak to you as an expert, but it seems certain that the problem of reclamation must differ with the circumstances of soil and situation, and that it is far more easy to do the wrong thing than the right. The first thing necessary is to find a Brémontier to show the way. We shall want a Brémontier to show us the way out of the pestilential quagmire which we Londoners are making by dint of large expenditure in the estuary of the Thames. We want a genius and enthusiast who will do for the bogs of Ireland what this great Frenchman did for the Landes of Gascony.[1]

[1] For many of the facts embodied in this address I am indebted to Dr. John Croumbie Brown's 'Pine Plantations on the Sand-Wastes of France.' Edinburgh (Oliver and Boyd), 1878.

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